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Supplementary Information Package (SIP) to the ESIA of the CBG Expansion Project

Third Release

Volume I - Appendices 9.1 to 9.6

COMPAGNIE DES BAUXITES DE GUINÉE

OCTOBER 5, 2015

PROJECT NUMBER: 15OTH076

PREPARED FOR:

Xavier van Lierde, Responsable Approvisionnement – Projet Extension
Compagnie des Bauxites de Guinée

APPENDICES

Appendix 9.1 Air quality and noise monitoring plan

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Infrastructure · Water · Environment · Buildings

Imagine the result

Compagnie des bauxites de Guinée (CBG)

CBG Production Expansion Project

Ambient Air Quality and Noise Monitoring Plan

September 2015

ARCADIS

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Ambient Air Quality and Noise Monitoring Plan

CBG Production Expansion Project

Prepared for:
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Our Ref.:
350854-004

Date:
September 2015

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A Monitoring Procedures

1. Introduction

1.1 Background

CBG (Compagnie des bauxites de Guinée) is a mining company jointly owned by the Government of Guinea and Halco Mining (Alcoa, Rio Tinto Alcan and Dadco). CBG is currently considering the extension of its bauxite production (referred to as the *Project*) from the current annual capacity of 13.5 MTPA (million tonnes per annum at 3% moisture) up to 18.5 MTPA by 2019, and ultimately up to 27.5 MTPA by 2027.

In support of the planned Project, ARCADIS Canada Inc. (formerly SENES Consultants) was retained by EEM to assess the potential effects of the Project activities on ambient air quality, noise and vibration levels in the Kamsar and Sangarédi areas. The air quality and noise and vibration assessments formed part of the Environmental Impact Statement (EIS) submitted to the Government of Guinea by CBG in January 2015.

1.2 Previous Monitoring Efforts

As part of the assessments for the EIS, CBG completed monitoring of ambient air quality and noise from February to May 2014 in both Kamsar and Sangarédi. ARCADIS assisted EEM and CBG in the development of the field work plan and advised CBG on the purchase of monitoring equipment and sampling media. The basic procedure consisted of:

- Measuring continuous meteorological data at the identified temporary weather station locations in Kamsar and Sangarédi (non-simultaneously);
- Measuring ambient air concentrations of particulate matter (and its metallic constituents) by collecting multiple 24-hour filter samples at the identified air quality monitoring locations (two (2) in Kamsar and six (6) in Sangarédi);
- Measuring ambient air concentrations of gaseous compounds by collecting passive gas samples at the identified air quality monitoring locations (one (1) in Kamsar and two (2) in Sangarédi) over a period of 30 days at each location;
- Continuously measuring sound levels at each identified noise monitoring location (four (4) in Kamsar and fifteen (15) in Sangarédi) over a period of forty-eight (48) hours at each location; and

- Validating and correcting the ambient air quality and noise data to remove anomalous events using available meteorological data, sample analysis data, and field notes.

ARCADIS also prepared standard operating procedures for the monitoring equipment, which were provided to CBG staff. CBG staff carried out all field monitoring activities and were responsible for shipping the collected samples to the laboratory for analysis. Analysis of the ambient air quality samples was completed by Maxxam Analytics, an accredited Canadian laboratory. ARCADIS was responsible for interpreting the laboratory results in conjunction with the instrument operating data logged in the field notes to develop the baseline air quality concentrations for use in the impact assessment.

1.2.1 Instrumentation

The ambient air quality monitoring equipment consisted of the following:

- Six (6) MiniVol portable air samplers, complete with two (2) sets of three (3) air inlet heads; each head is suitable for measurement of one of the various particulate size fractions evaluated as part of the monitoring program (i.e., TSP, PM_{10}, $PM_{2.5}$);
- Three (3) shelters/stands for the passive gas samples, with each shelter capable of holding up to three (3) samples (i.e., NOx, NO_2 and SO_2); and
- One (1) field calibration unit for the MiniVols.

The meteorological monitoring equipment consisted of the following:

- One (1) NovaLynx portable weather station complete with solar panel.

The ambient noise monitoring equipment consisted of the following:

- Two (2) Larson Davis LxT sound level meters (Class 1) with associated mounting stands and environmental enclosures; and
- One (1) acoustic field calibrator for the sound level meters.

Both the MiniVol particulate samplers and the sound level meters (and respective field calibrators) were factory calibrated in early 2014 before they were supplied to CBG (in March 2014). The calibration period of these pieces of equipment is one (1) year and has now lapsed.

1.2.2 Monitoring Locations

As part of the 2014 field work plan, ARCADIS provided CBG with a list of preferred monitoring locations (see Figure 1 and Figure 2). Due to the limited equipment and security concerns, the monitoring was completed on a campaign basis such that all of the equipment was first deployed in Kamsar in March 2014, before being decommissioned and relocated to the Sangarédi area in April and May 2014.

1.3 Scope of this Plan

Subsequent to the receipt of technical review comments on the EIS provided by Ramboll Environ, ARCADIS has developed this current monitoring plan to detail the methodologies to be used in the collection of additional ambient air quality and noise measurements on an ongoing basis.

CBG will be responsible for all field monitoring activities going forward; however, ARCADIS and EEM are providing technical and logistical assistance during the initiation phase of the monitoring plan (September to November 2015). As a starting point, this plan has been developed around the initial phase of CBG's planned production increase to 18.5 MTPA. During this phase of the Project, production activities in the Sangarédi area will be located nearby CBG's existing mining operations, with some expanded activities near Hamdalaye and south of Sangarédi.

The monitoring plan is intended to be adaptive, in order to allow for CBG monitoring activities to expand to reflect increased production and new information gathered through monitoring. It is anticipated that specific aspects of the monitoring plan (e.g., precise number and location of monitoring locations) will be re-evaluated by CBG as monitoring progresses and more information becomes available.

The monitoring plan includes the following:

- recommended sampling locations;
- the sampling strategy to be used at each site (i.e., number of samples of each type, at each location);
- information to be recorded in the project field manual; and
- the laboratory analyses to be used for the samples.

2. Field Monitoring

2.1 Meteorology

2.1.1 Instrumentation

It is understood that CBG has a meteorological tower at the Kamsar facility which is currently out of commission. ARCADIS recommends that this station be refurbished so that a permanent meteorological station is operational in the Kamsar area. Until this station is refurbished, it is recommended that the NovaLynx meteorological station used in the 2014 monitoring campaign be commissioned in its place.

Data from a permanent, long-term operating meteorological station in the Sangarédi area has recently become available and will be used in this monitoring campaign.

2.1.2 Monitoring Locations

The locations for the weather stations in Kamsar and Sangarédi are shown in Figure 1 and Figure 2, respectively.

ARCADIS recommends that the Kamsar weather station be co-located with the proposed permanent ambient air quality monitoring station (see Section 2.2).

2.1.3 Frequency of Sampling

Once the weather station in Kamsar is re-established, it is recommended that it made a permanent location (pending the refurbishment of the existing meteorological tower at the Kamsar facility). The weather data support the data requirements of the ambient air quality and noise monitoring programs and are necessary for ongoing validation of the air dispersion modelling. Data from the weather stations at Kamsar and Sangarédi should continue to be collected for the duration of the project.

2.2 Ambient Air Quality Monitoring

2.2.1 Instrumentation

The ambient air quality monitoring equipment purchased for the previous field monitoring campaign (see Section 1.2.1) included six (6) MiniVol particulate samplers and three (3) passive gas sampling stands. In addition, ARCADIS understands that CBG will be establishing a permanent ambient air quality monitoring station at the Kamsar Ecole location and has purchased the following equipment:

- Two (2) continuous particle counters (e.g., beta attenuation monitor or similar) that each measure one of two particulate size fractions (TSP, $PM_{2.5}$);
- One (1) SO_2 UV fluorescence analyzer; and
- One (1) NOx/NO_2 chemiluminescence analyzer.

Previously, the MiniVols were configured such that three (3) particulate size fractions (TSP, PM_{10}, $PM_{2.5}$) were sampled simultaneously at each monitoring location, which allowed for simultaneous measurements at two (2) air monitoring stations. Going forward, ARCADIS recommends that the MiniVols be reconfigured to three (3) sets of paired samplers measuring only two (2) size fractions: TSP and $PM_{2.5}$.

For the 2015/2016 field season, one (1) pair of particulate samplers and one (1) passive gas sampling system should remain at the permanent ambient air quality monitoring station in Kamsar, once it is fully commissioned. This will allow the performance of the continuous monitors to be compared and validated against the MiniVols and passive gas samplers. The remaining two (2) pairs of MiniVols and two (2) passive gas sampling stands will be rotated through the rest of the ambient air quality monitoring stations in Kamsar and Sangarédi.

Due to the logistical challenges associated with moving between sampling sites in Sangarédi, ARCADIS recommends that CBG investigate purchasing two (2) additional MiniVols (i.e., paired set for TSP and $PM_{2.5}$) and one (1) additional passive gas sampling stand. This would alleviate the need to move equipment between Kamsar and Sangarédi and potentially allow for spares in the event that there are operational issues with any of the samplers.

2.2.2 Monitoring Locations

The suggested locations for the ambient air quality monitoring stations in Kamsar and Sangarédi are shown in Figure 1 and Figure 2, respectively.

CBG will collect air quality monitoring data at fixed and temporary ambient locations to both capture the effect of the existing Kamsar operations and background conditions. To capture air quality conditions which are removed from the direct influence of CBG's Kamsar processing facility, while remaining representative of the conditions in the Kamsar area, ARCADIS recommends that CBG add a background air quality monitoring station at the Kamsar Airport.

In addition to the fixed location at Kamsar Ecole (co-located with the meteorological tower - AQ-2 Ecole (from 2014 monitoring program)), the remaining temporary ambient air quality monitoring stations are as follows:

- One (1) location near the north fence line of CBG's Kamsar processing facility (AQ-1 Alcoa (from 2014 monitoring program) (see Figure 1);
- One (1) additional location at the Kamsar Airport;
- Seven (7) locations in the Sangarédi area, including:
    - Four (4) locations that were visited in 2014;
    - Two (2) new locations near Boulléré and Souka; and
    - One (1) new location near Dounsi.

The three (3) new monitoring stations (as shown in Figure 2) stations are intended to represent the ecologically sensitive areas near the towns of Boulléré and Souka, as well as capture the influence of CBG's existing mining activities east of Sangarédi near Dounsi. It is recognized that the specific locations of these stations may have to be adjusted once the field monitoring has begun, in order to take account of local considerations such as access and security. However, once the stations are established, the locations should kept consistent in subsequent monitoring campaigns.

The initial monitoring program is to be focused on activities associated with the 18.5 MTPA extraction scenario, which involves mining primarily in areas close to the current CBG extraction areas and the ecologically sensitive areas near the towns of Boulléré, Souka and Kourawel. As such, the monitoring location near Pavari is optional during the 2015/2016 field season but should be included in the sample program as CBG's mining activities expand west in the following years.

2.2.3 Frequency of Sampling

Due to the intense rainfall typical during the rainy season, it is anticipated that ambient air quality monitoring will be suspended during this period (July through September each year) (Table 1).

In order to appropriately characterize seasonal variability in ambient air quality, ARCADIS recommends a minimum of four (4) monitoring campaigns in both Kamsar and Sangarédi as follows:

- A campaign in October/November that captures the end of the rainy season;
- Two campaigns between December and April that capture the conditions typical of dry season, including the effects of the Harmattan; and
- A campaign in May/June that captures the beginning of the rainy season.

Each campaign will consist of the following:

- One (1) passive gas sampler (complete with cartridges for SO_2, NO_2 and NOx) placed at each air quality monitoring station for a period of 30 days.
- Two (2) MiniVol particulate samplers (complete with heads equipment for sampling of TSP and $PM_{2.5}$ fractions) placed at each air quality monitoring station for a period of 24 hours. Each sampling location should be revisited every six (6) days over a period of one (1) month, resulting in a minimum of four (4) samples of each particulate fraction (TSP and $PM_{2.5}$) at each location.

2.3 Ambient Noise Monitoring

2.3.1 Instrumentation

The ambient noise monitoring equipment purchased for the previous field monitoring campaign (see Section 1.2.1) included two (2) Larson Davis LxT sound level meters (Class 1) and associated environmental enclosures. Both sound level meters will be rotated through the ambient noise monitoring stations in Kamsar and Sangarédi.

Due to the logistical challenges associated with moving between monitoring sites in Sangarédi, ARCADIS recommends that CBG investigate purchasing two (2) additional sound level meters, which would alleviate the need to move equipment between

Kamsar and Sangarédi and potentially allow for spares in the event that there are operational issues with any of the sound level meters.

2.3.2 Monitoring Locations

The suggested locations for the ambient noise monitoring stations in Kamsar and Sangarédi are shown in Figure 1 and Figure 2, respectively. In total, there will be 27 temporary ambient noise monitoring stations that will be visited on a recurring basis throughout the life of the project, as necessary based on the anticipated mining locations. These stations are as follows:

- Five (5) locations in Kamsar, including:
  - Four (4) locations near the CBG's Kamsar processing facility; and
  - One (1) additional station to be co-located at the Kamsar Airport with the weather station and permanent air quality station (see Figure 1).
- 21 locations in the Sangarédi area, including:
  - 15 locations that were visited in 2014; and
  - Four (4) locations that were proposed for 2014 but not visited, and two (2) new locations near Boulléré and Souka.

The two (2) new monitoring stations (as shown in Figure 2) stations are intended to represent the ecologically sensitive areas near the towns of Boulléré and Souka. It is recognized that the specific locations of these stations may have to be adjusted once the field monitoring has begun, in order to take account of local considerations such as access and security. However, once the stations are established, the locations should kept consistent in subsequent monitoring campaigns.

The initial monitoring program is to be focused on activities associated with the 18.5 MTPA extraction scenario, which involves mining primarily in areas close to the current CBG extraction areas. As such, it is anticipated that it will not be necessary to monitor at all 15 of the former monitoring locations in Sangarédi. In addition to the four (4) locations that were not visited in 2014 and the two (2) new locations, it is proposed that noise monitoring in the first year occur at the following previous locations:

- Hamdallay;
- Fassali;
- Samayabhe;

- Petoun Bondoue Wande;
- Dounsi;
- Parawol Sitako; and
- Kogon Lingue.

2.3.3 Frequency of Sampling

Due to the intense rainfall typical during the rainy season, it is anticipated that ambient noise monitoring will be suspended during the period from July through Septermber each year. In order to appropriately characterize seasonal variability in noise, ARCADIS recommends a minimum of four (4) monitoring campaigns in both Kamsar and Sangarédi as follows:

- A campaign in October/November that captures the end of the rainy season;
- Two campaigns between December and April that capture the conditions typical of dry season, including the effects of the Harmattan; and
- A campaign in May/June that captures the period before the rainy season.

Each campaign will consist of the following:

- One (1) sound level meter (complete with environmental enclosure) placed at each noise monitoring station for a period of 144 hours (6 days).

2.4 Underwater Noise Monitoring

ARCADIS understands that CBG has also committed to studying the effects of the Project on underwater noise levels in the Port of Kamsar. ARCADIS has yet not had an opportunity to review the details of these commitments; however, ARCADIS has extensive experience with underwater noise monitoring and modelling evaluations through our Carlsbad, California office. Once further details have been provided, ARCADIS can provide more guidance. Briefly, an evaluation of underwater noise in the Port of Kamsar would consist of:

- A detailed review of the profile of protected species present in the port area and development of suitable noise thresholds;

- A detailed review of the construction schedule, construction methods and proposed equipment (including frequency of activities with increased potential for noise impacts such as dredging and piling);
- A baseline monitoring program designed to capture ambient conditions at the locations where Project activity is anticipated (e.g., ship loading area, locations of new infrastructure such as jetties or channels);
- A theoretical noise modelling study for the prediction of potential sound impacts due to construction methods and equipment, such as rock dropping, dredging and piling. The noise propagation calculations would be applied to develop predicted zones of impact.

3. Laboratory Analyses

3.1 Ambient Air Quality Samples

Once the sampling of air quality parameters is complete at each site, the samples must be returned to an accredited laboratory for analysis, along with the field log and completed chain of custody form. For the initial samples, ARCADIS recommends Maxxam Analytics, which is the Canadian laboratory that completed the sample analysis for the 2014 monitoring efforts. CBG may wish to revisit the laboratory for future analyses, if an appropriately accredited laboratory can be identified.

At the lab, the filter samples (TSP, PM_{10} and $PM_{2.5}$) will undergo gravimetric analysis for total particulate deposited on them. Additionally, the TSP filters will undergo digestion and analysis for metals composition. Multiple TSP filters will be composited into groups for metals analysis (likely into 3 per location – 2 sample days each), since it is unlikely that sufficient sample will be collected on the individual TSP filters. This would represent analysis of every 2 TSP samples. The metals included in this analysis will be (at minimum):

- Aluminum
- Antimony
- Arsenic
- Cadmium
- Chromium
- Chromium VI
- Copper

- Nickel

The passive cartridges will undergo analysis for absorbed NOx, NO_2 and SO_2. The laboratory will also request records of site meteorological conditions during the period that the cartridges were exposed (typically 30 days).

3.2 Equipment Recalibration

Some of the ambient air quality and noise monitoring equipment outlined above must be recalibrated by the equipment manufacturers on an annual basis. CBG must ensure that this equipment is maintained within calibration while it is being used and that the calibrations are traceable to appropriate national standards bodies (e.g., NIST). The equipment that requires annual recalibration includes:

- Six (6) MiniVol portable air samplers and one (1) field calibration unit for the MiniVols, which is manufactured by Airmetrics in Springfield, Oregon, U.S.A.; and
- Two (2) Larson Davis LxT sound level meters (Class 1) and one (1) acoustic field calibrator, which is manufactured by The Modal Shop Inc. in Cincinnati, Ohio, U.S.A.

The CBG air and noise monitoring equipment was last calibrated by the equipment manufacturers in early 2014 before they were supplied to CBG (in March 2014). As such, the equipment will require recertification prior to being deployed in the next phase of monitoring.

4. Summary of Recommendations

1) ARCADIS recommends that CBG immediately send the following equipment for recalibration:
   - Six (6) MiniVol portable air samplers and one (1) field calibration unit; and
   - Two (2) Larson Davis LxT sound level meters and one (1) acoustic field calibrator.

2) ARCADIS recommends that CBG investigate purchasing the following additional monitoring equipment:
   - One (1) NovaLynx portable weather station complete with solar panel;
   - Two (2) continuous particle counters (e.g., beta attenuation monitor or similar) that each measure one of two particulate size fractions (TSP, $PM_{2.5}$);
   - One (1) SO_2 UV fluorescence analyzer;
   - One (1) NOx/NO_2 chemiluminescence analyzer;
   - Two (2) MiniVol portable air samplers and one (1) field calibration unit; and
   - Two (2) Larson Davis LxT sound level meters and one (1) acoustic field calibrator.

3) ARCADIS recommends that the Kamsar weather station and the proposed background air quality monitoring station be established together at the Kamsar Airport. This location should also be included in the ambient noise monitoring campaigns.

4) ARCADIS recommends that three (3) additional ambient air quality and six (6) additional ambient noise monitoring stations be established in Sangarédi, as shown on Figure 2.

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Tables

Table 1 Boké Climate Normals (1961-1990)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Temperature 30-year Mean (°C)	26.3	27.9	29.1	29.7	28.3	27.1	27.4	25.4	24	26.8	28.2	27.2	27.28
High Temp. 30-year Mean (°C)	39.7	38.4	40.5	40.1	38.5	35	32.8	32.4	33.1	33.9	35.5	35.7	36.3
Low Temp. 30-year Mean (°C)	14.4	15.7	17.7	19.9	20.9	20.4	20.7	20.5	19.7	20.1	18.1	14.4	18.54
Precipitation Mean (mm)	0	0.1	0.2	9	105	258	485	424	545	317	67	2	184.36
Relative Humidity Mean (%)	53	58	53	55	67	76	75	82	92	78	69	58	68

Source: World Climate (2014)

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Figures

Figure 1 **Ambient Air Quality and Noise Monitoring Locations in Kamsar**

LEGEND:

- Air Quality Monitoring Stations (2014)
- New Air Quality Monitoring Stations
- Noise Monitoring Stations (2014)
- New Noise Monitoring Stations

NOTES:

SCALE:

0 m 1,000 m 2,000 m

REVISIONS:

No.	Date	By	Revisions

REFERENCE:

Basemap: Google Earth 2014

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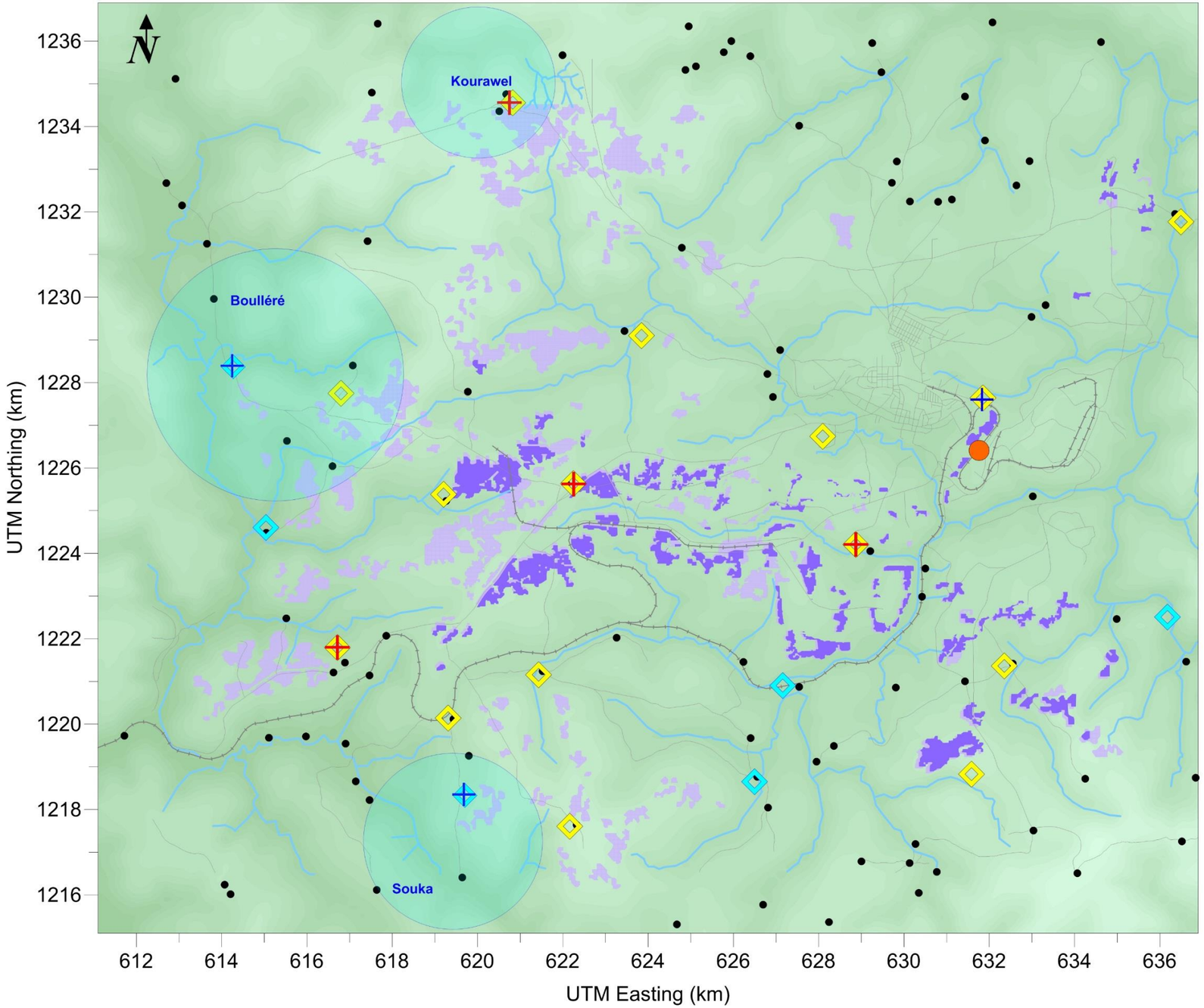
Compagnie des bauxites de Guinée (CBG)

Final Air and Noise Monitoring Locations

Kamsar, Guinea

Drawn By:	Approved By:	Figure No.:
KT	JLK	1
Date: Sept. 2015	**Project Number:** 350854	

Figure 2 **Ambient Air Quality and Noise Monitoring Locations in Sangarédi**



Legend:

- Sensitive Receptors (villages)
- Air Quality Monitoring Stations (2014)
- New Air Quality Monitoring Stations
- Noise Monitoring Stations (2014)
- New Noise Monitoring Stations
- Meteorological Tower
- Railway
- Roads
- Rivers
- Extraction areas
- Active extraction areas (2015-2019)
- Land Animals - Key Areas

Scale:

0 — 6.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

ARCADIS

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Sangarédi Mining Area
Boké, Guinea

Air and Noise Monitoring Locations

Date:	Project No.:
Sept. 2015	350854

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Appendix A

Monitoring Procedures

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MEMO

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From:
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Jamie Fletcher

Date:
31 August 2015

ARCADIS Project No.:
350854-003

Subject:
Sampling Protocol for the AirMetrics Mini-Vol Particulate Monitoring System

---

OVERVIEW OF INSTRUMENT

The Airmetrics MiniVol is a portable sampling device that can be used to sample Total Suspended Particulates (TSP), Particulate Matter less than 10 µm (PM_{10}, also known as inhalable particulates) and Particulate Matter less than 2.5 µm ($PM_{2.5}$, also known as respirable particulates). The MiniVol unit houses a pump that is engaged to draw ambient air across an in-line filter medium for the collection of particulate matter. For samples of PM_{10} and $PM_{2.5}$, the inlet air first passes through a particle size separator prior to encountering the filter. The sampler can be powered using DC power from the rechargeable batteries supplied with the unit, or AC power, by plugging the charger into an AC source.

Prior to deployment in the field for collection of samples, it is important to first calibrate the units. This process, described below, involves creating a calibration curve for the instrument, which relates the flow indicated by the flowmeter to an actual flowrate determined by a flow orifice that has a calibration traceable to an NIST standard. The calibration curve is then used to calculate a flowmeter set-point such that the instrument is operating at the required flow rate of 5 lpm.

Once calibrated, the deployment of the instrument for the collection of samples involves installing the filter media to the air intake apparatus, setting the timer for the appropriate on/off times to ensure a sample of appropriate duration, and recording instrument settings and sample descriptors in a field log. The details of these steps are provided below.

EQUIPMENT CHECKLIST

At each location, three (3) sampling units are required to be installed, which will include one Mini-Vol for each particulate matter size fraction (i.e. TSP, PM_{10} and $PM_{2.5}$). For each sampling run the equipment consists of the following:

- Three (3) MiniVol™ TAS Pump Modules;
- Three (3) Filter Holder Assemblies, including one (1) standard TSP assembly and two (2) size selective inlets for PM_{10} and $PM_{2.5}$;
- Three (3) Battery Packs and a Battery Charger;
- Three (3) All Weather Carrying Cases;
- Three (3) Universal Mounting Brackets;
- One (1) tube of impactor grease;
- Three (3) 47 mm filters in pre-assembled cartridges (provided by Lab);
- One (1) field calibration kit including calibration orifice and flow measurement device (magnahelic or manometer)
- Field log book

IMPORTANT: Quality Assurance / Quality Control (QA/QC) steps are an important component of any environmental sampling program. Specific protocols and procedures should be used to ensure and verify that high quality, representative data is collected throughout the entire sampling program. Please review the complete Mini-Vol operating manual provided in Appendix A prior to use of any equipment. This manual provides step-by-step instructions on the operation of the Mini-Vol samplers.

SITING REQUIREMENTS

1. There are a number of technical siting requirements (per EPA guidance), which should be considered when siting the MiniVol samplers:

    a. The sampler should be >20 meters from trees (dripline);

    b. The distance from the sampler to obstacles, such as buildings, should be *twice the height of the obstacle*.

    c. The sampler should have unrestricted airflow 270 degrees around the sampler inlet;

    d. The sampler inlet must be between 2-15 meters above the ground;

e. Avoid locating the sampler in areas where excessive contamination may occur that would not be considered typical of normal background conditions.

The sampler should be situated where the operator can reach it safely despite adverse weather conditions. Consideration also should be given to the fact that routine operation (i.e., calibration, filter installation and recovery, etc.) involves transporting supplies and equipment to and from the monitoring site.

2. Find a suitable location or supporting structure that can be used to secure the MiniVol assemblies. The MiniVol universal mounting bracket is designed to be used in a variety of situations (**Figure 1**). It comes configured to be mounted on a 2" OD or smaller pipe, fence post or other metal tubing. The quick release bracket extension also allows the bracket to be mounted either vertically or horizontally. By removing the stainless steel u-bolts and plastic vee-blocks, the bracket may strapped to a larger diameter object such as a light or power pole.

3. Figure 1: MiniVol Vertical Mount

CALIBRATION

The MiniVol is designed to operate at an actual flow rate of 5.0 L/min. As such, the on-board rotameter that is used to set the flow rate on the MiniVol must be calibrated to ensure that the *indicated* flow (i.e., displayed by the rotameter) can be set such that the *actual* flow is 5.0 L/min. This is accomplished using a transfer standard that has a calibration traceable to the U.S. Institute of National Standards and Technology (NIST) to determine the actual flow rates associated with a range of indicated flow rates, and developing a calibration curve that may be used to establish the rotameter set-point.

Calibrations should be completed *monthly*, as well as *after any service/maintenance* has been completed.

1. Open a copy of the spreadsheet *350854-004 Minivol Calibration Workbook.xlsx*, and navigate to the *Calibration* tab. The highlighted cells represent user inputs. Begin by entering the date, the ID of the unit that is being calibrated, the name of the technician completing the calibration, and the ambient temperature and pressure conditions present during the calibration process.

2. Open the calibration kit, and locate the information card titled *NIST Traceable Transfer Standard Calibration*. Locate the linear regression results on this card, and enter the slope and intercept (m_{flo} and b_{flo}) to the calibration spreadsheet where indicated.

3. Place a filter into the MiniVol sampler filter holder and attach the filter holder assembly to the sampler. *Note: filters used for flow rate calibrations should not be used for subsequent sampling*. Turn the MiniVol sampler on by pushing ON/AUTO/OFF once, and allow the unit to warm up for 2 minutes.

4. Slide the calibration orifice onto the end of the filter holder assembly, and connect the tubing from the nozzle on the calibration orifice to the nozzle on the flow measuring device included in the calibration kit (i.e. magnahelic, manometer, etc.).

5. Adjust the flow control knob until the rotameter displays a flow of 6.5 lpm. Enter the associated pressure drop reading from the manometer or magnahelic (in. H_2O) to the spreadsheet in the ΔH column of the calibration table for the Q_{ind} (indicated flowrate) value of 6.5 lpm.

6. Repeat the above steps for rotameter (Q_{ind}) flowrates of 6.0, 5.5, 5.0, 4.5 and 4.0 lpm.

7. The spreadsheet will automatically calculate the linear regression constants for the input data in the section of the spreadsheet titled *MiniVol Sampler Calibration Constants*. Check to make sure that the *Regression Check* and *Accuracy Check* cells both indicate “OK”. If either of these cells indicate “Fail”, then tighten the tubing connections and repeat steps 5 and 6. In order for a calibration to be valid, the R^2 value for the linear regression must be greater than 0.990, and no single flow rate that is predicted from the regression constants should differ from the calculated value by more than 2%.

8. Turn the unit off by pushing ON/AUTO/OFF twice, and remove the flow orifice and filter holder assembly.

PREPARING FOR SAMPLE COLLECTION

1. Ensure that a suitable amount of filter media is available for the sampling program by completing a weekly inventory, and projecting future use such that additional inventory may be ordered well in advance.

2. Ensure that batteries are charged for use. Connect the charging plug of the battery charger to the charging jack on the battery pack and allow the battery to charge for a minimum of 18 hours prior to use (See Section 2.2 of the Operations Manual for addition details).

3. Prior to deploying the samplers each time, first open the *350854-004 Minivol Calibration Workbook.xlsx* spreadsheet and navigate to the *Calibration* tab. Under *MiniVol Setpoint Calculation* section, enter the temperature and pressure at the sample location (e.g., from a weather station) and note the required flow meter setpoint for each MiniVol to be deployed. Enter the temperature, pressure and set-point flow rate for each sampler in the Field Log that is to be taken into the field when deploying the units.

PREPARING THE AIR INLET ASSEMBLIES

The configuration of the filter holder assemblies differs according to the size fraction of particulate that is being sampled (TSP, PM_{10} or $PM_{2.5}$). Samples of PM_{10} and $PM_{2.5}$ each require the use of impactors in the inlet assembly to remove the required size fraction of particulate from the air stream that passes the filter media. Diagrams of the PM_{10} and $PM_{2.5}$ assemblies are provided in Figure 2 and Figure 3, respectively.

Figure 2: PM_{10} Impactor/Filter Holder Assembly

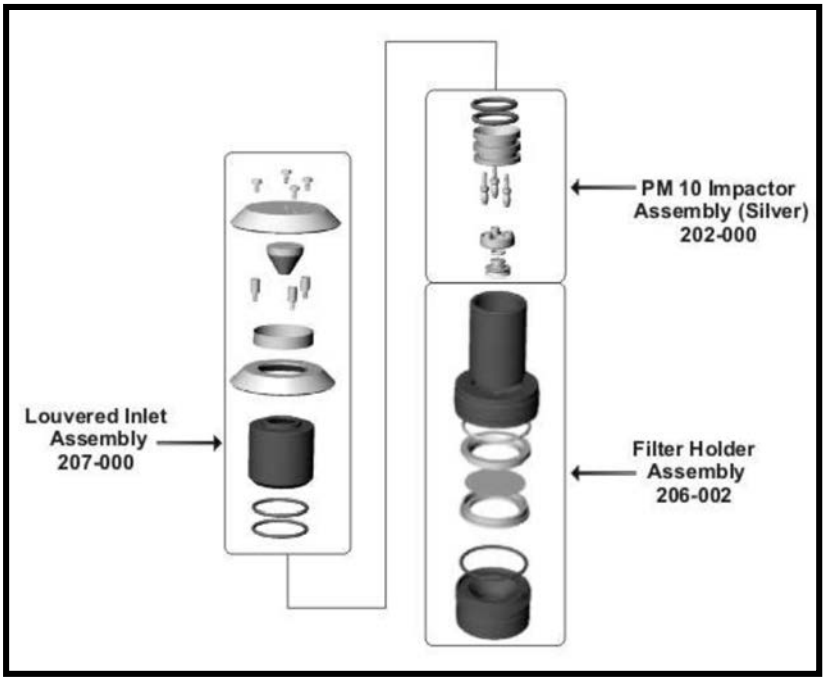
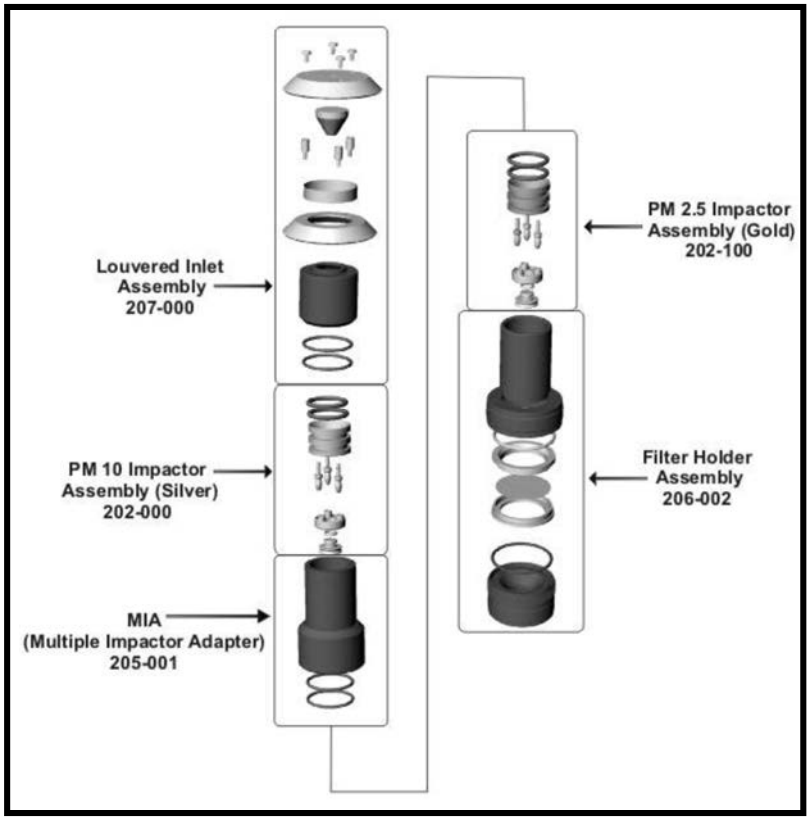


Figure 3: $PM_{2.5}$ Impactor/Filter Holder Assembly



1. In a clean indoor workspace, set aside three (3) unused pre-weighed 47-mm filters from the laboratory and the three (3) air inlet assemblies for the MiniVols.

2. Load one filter into each of the three (3) Petrislide filter holder cassettes, and note the filter ID (provided by the laboratory, and unique for each filter) that has been assigned to each MiniVol unit. Once assigned, ensure that the filters remain with the unit they are assigned to. This is imperative for proper tracking of samples.

3. Assemble the PM_{10} and $PM_{2.5}$ inlets in accordance with Figure 2 and Figure 3, respectively. Note that greasing and cleaning of the impactor target disk is to be completed at the outset of the program, and after every fifth sample:

    a. To remove the impactor from the assembly, use your thumb to push the impactor out of its tube from bottom to top.

b. Pull the Easy Maintenance Target (EMT) (at the base of the impactor, held in place by an o-ring; see Figure 4) away from the impactor.

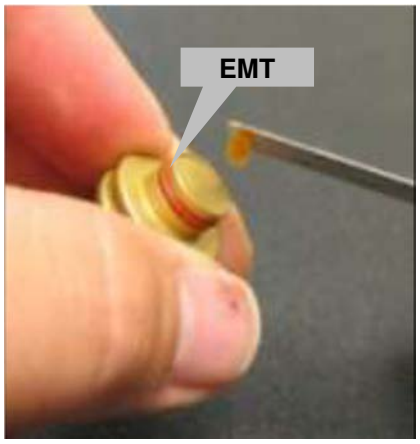
c. Wipe the surface clean with a lint-free cloth or paper towel.

d. Apply a thin coating of low vapour pressure grease directly on the surface of the EMT. The EMT has a 0.015" recess for even application of the grease.

e. Wipe any excess grease from the edges of the EMT, and reinsert it to the impactor.

f. Slide the impactor back into the tube, such that its top is flush with the surrounding filter holder assembly tube or multiple impactor adapter tube.

Figure 4: Easy Maintenance Target (EMT)



4. Install the filter cassettes to the inlet assemblies, and place each in a separate zip lock bag to minimize contamination.

SAMPLER OPERATION

1. As noted in the *Preparing for Sample Collection* section of this document, it is important to know the set-point flow rates for each unit *prior to deployment in the field*. This will ensure that the units operate at an actual flow rate of 5 lpm during the measurement. Ensure that the Field Log to be taken into the field when deploying the instruments includes the set-point flow rate for each unit *prior to departing* to set up the monitors. This calculation is completed in the *350854-004 Minivol Calibration Workbook.xlsx* spreadsheet.

2. At the monitoring location, remove the clean Impactor/Filter Holder Assembly from the plastic transport bag or case. Attach the Impactor/Filter Holder Assembly to the top of the sampler inlet tube.

3. Install a fully charged battery to the MiniVol.

4. Record the following information on the Field Log:

    a. Sample location, date and technician
    b. Filter ID,
    c. Sampler ID,
    d. Ambient temperature and pressure,
    e. Elapsed time meter reading.

5. Open the sampler case and set the starting flow rate on the rotameter to the set-point flow rate. To complete this step, press the ON/AUTO/OFF button to start the pump. On the LCD display, the horizontal bar should move to "ON". Using the Flow Rate Adjustment control (see Figure X), set the rotameter to the set-point derived from the calibration data (which should already be noted on the Field Log). Take the reading of the flowmeter from the center of the ball. Record the starting flow rate from the rotameter in the field log.

6. Press the ON/AUTO/OFF button twice to stop the pump.

7. Determine the time of the day when the sampler is to turn on and off. Program the timer to turn the sampler on and off at these times (Also see "Programming the Timer" in Section 2.4 of the MiniVol Operation Manual). To set the timer, first set the real-time clock to establish the correct time frame in which the cycles are to run. Next, enter the on/off time at which the programmed cycle is to begin and end. The steps are outlined in more detail below.

    a. Setting the Real-Time Clock:

        i. DAY SET: Hold down the CLOCK button and press the WEEK button until the correct day appears at the top of the display.

        ii. TIME SET (Hour): Hold down the CLOCK button and press the HOUR button until the display indicates the correct hour. You may have to cycle through the hours twice to obtain the proper AM or PM (on the left side of the display). Seconds will automatically reset to zero.

iii. TIME SET (Minutes): Hold down the CLOCK button and press the MIN button until the display indicates the correct minutes. Seconds will automatically reset to zero.

b. Setting the On/Off Times

i. Press the PROG button once. 1^{ON} will appear near the lower left corner of the display indicating that the Power-on time for the first cycle is ready to be programmed.

ii. Press the HOUR and MIN buttons to enter the power-on time for the first cycle. As with the real-time clock, cycle through as necessary to select the appropriate time with regard to AM or PM.

iii. Press the WEEK button to select the desired day. The days appear along the top of the display. Continuously pressing the WEEK button will sequentially display a series of pre-sets, including multi-day periods. Select the individual day of the week that the unit is to automatically start running.

iv. After you have entered the power-on time and date for the first cycle, press the PROG button. 1^{OFF} now appears on the display to indicate that the power-off time for the first cycle is ready to be programmed. Repeat steps ii and iii to enter the desired power-off time.

v. The power-off time does not have to occur on the same day as the on time. In this way, sampling may start on one day and end on the next day.

vi. Press the PROG button again. 2^{ON} appears on the display. This allows additional sample periods to be programmed, which is not necessary for this monitoring program. If there is a time displayed, press the RST/RCL button to disable any time entries. When you disable a particular power-on/off entry, four dashes will appear instead of the time. If you reactivate an entry (by pushing RST/RCL again), it will return to the values that were set before you performed a reset.

vii. Cycle through the program times and disable all entries for $2^{ON/OFF}$, $3^{ON/OFF}$, $4^{ON/OFF}$, $5^{ON/OFF}$ and $6^{ON/OFF}$. Both ON and OFF entries need to be disabled for the unwanted programs to be inactive.

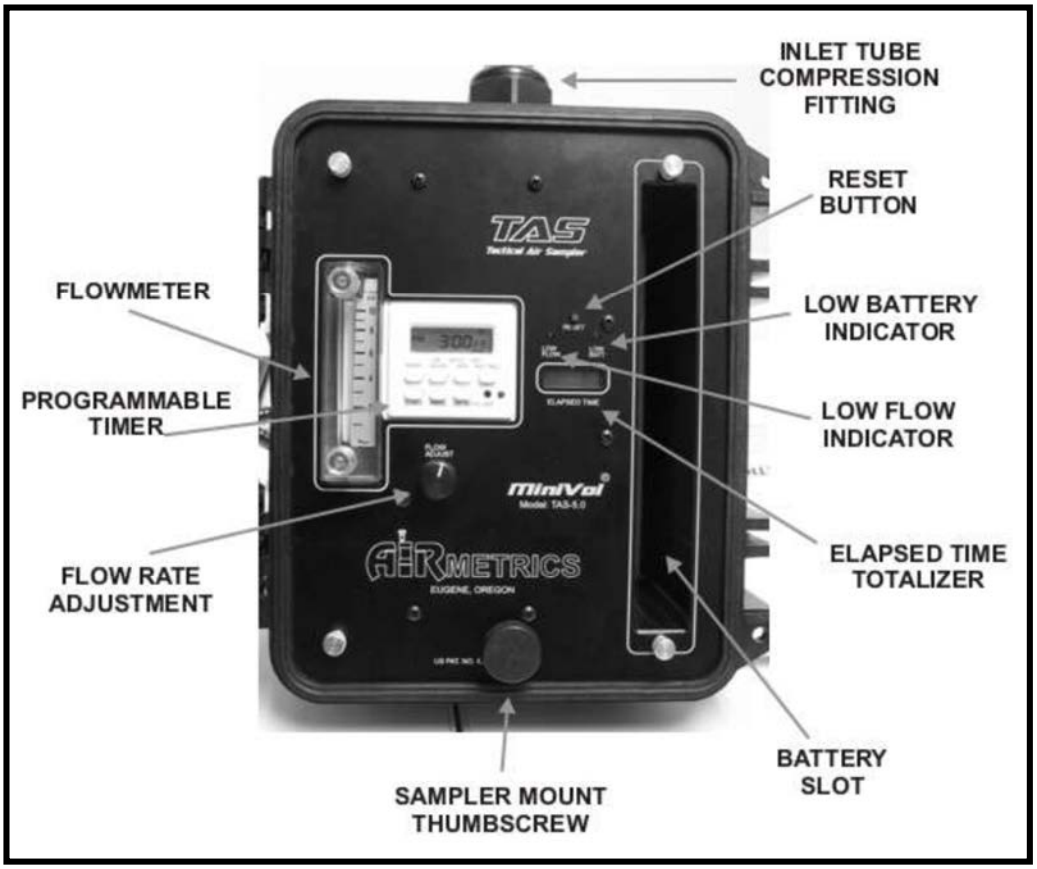
viii. Press the CLOCK button to return to the real-time clock display.

ix. Press the ON/AUTO/OFF button until the bar is positioned above the AUTO setting.

8. Close the sampler case.

9. For each additional Mini-Vol sampler repeat Steps 2 – 9 above.

Figure 5: MiniVolSampler Layout



RETRIEVING SAMPLES

As soon as possible after the end of the sampling period, the operator should return to the monitoring site to retrieve the exposed filter. There is a potential for filter damage or changes in sample mass due to particle loss/passive deposition if the filter is left in the sampler for extended periods of time.

1. Open the sampler case check the sampler for any error conditions. If an error condition exists refer to the "Error Conditions" section 4.18 in the MiniVol Operation Manual. Report any error conditions to ARCADIS.

2. Verify correct time and day of week on time LCD.

3. Record the elapsed time on Field Log as shown on the Elapsed Time Totalizer.

4. Record the ending flow rate on the Field Log:

    a. Press the ON/AUTO/OFF button to start the pump.

    b. With the flow meter in a vertical position, record flow rate to the nearest 0.25 lpm (read at center of ball).

    c. Press the ON/AUTO/OFF button twice to stop the pump.

5. Record the ambient temperature (Ta), barometric pressure (Pa) in the Field Log;

6. Perform a crosscheck of the exposed filter number with the information recorded in the Field Log for the run just completed.

7. Place the Impactor/Filter Holder assembly into the protective plastic case.

8. Transport the used Impactor/Filter Holder assembly to an indoor location in the protective plastic case provided. Keep all samples in a secure dust free place until ready for shipment to the lab.

9. Maintain a log of all samples and fill out a sample chain of custody form that includes all samples. Record all transfers, each time the samples change custody (i.e. given to a courier for shipping).

10. Send the samples back to the laboratory for post-weighing and any subsequent analyses and include a copy of the Maxxam chain of custody form.

11. Repeat Steps 1 through 12 for each MiniVol (as appropriate).

CALCULATIONS

1. Provide ARCADIS with copies of all field and calibration data logs on a weekly basis. All filters should be directed to ARCADIS for submission to Maxxam Analytics for laboratory analysis.

METHOD FOR CONTINUOUS NOISE MONITORING

Principles of Operation

Sound-level meters are used to measure the intensity of sounds. A typical meter consists of a condenser microphone for picking up the sound and a preamplifier for converting it into an electrical signal that can recorded by the noise meter. The noise meter is calibrated to read the sound level in decibels (dB; a logarithmic unit used to measure the sound intensity). The electronic circuitry can be adjusted to read the level of most frequencies in the sound being measured or the intensity of selected bands of frequencies (1/1 or 1/3 octave bands). A typical sound-level meter can be switched between a scale that reads sound intensities uniformly for most frequencies (unweighted) and a scale that introduces a frequency-dependent weighting factor, which yield a response more nearly like that of the human ear. A-frequency-weighting is the most commonly used standard, but C- and Z-frequency-weightings are also included. The A-frequency-weighting scale is useful in describing how complex noises affect people.

Required Equipment: Noise Meters

At each location, one (1) noise monitoring station (NMS) is required to be installed. For each sampling location the equipment consists of the following:

- One (1) Larson Davis LxT noise meter
- One (1) microphone
- One (1) pre-amplifier
- One (1) acoustic calibrator (CAL200)
- One (1) microphone/pre-amp extension cable
- One (1) environmental shroud (pre-amp housing, foam windscreen and bird spike assembly)
- One (1) battery (fully charged)
- One (1) battery connector cable
- One (1) supporting tripod and PVC mounting bracket
- One (1) pelican case
- Dessicant packs
- Field log book

IMPORTANT: Quality Assurance / Quality Control (QA/QC) steps are an important component of any environmental sampling program. Specific protocols and procedures should be used to ensure and verify that high quality, representative data is collected throughout the entire sampling program. P**lease review the complete Larson Davis LxT**

operating manuals provided in Appendix A prior to use of any equipment. This manual provides step-by-step instructions on the operation of the Noise Monitoring System (NMS).

Siting / Testing Requirements

1. There are a number of technical siting requirements, which should be considered when siting the NMS.

    a. The NMS **should** be located in close proximity to a receptor so that a representative sample of typical baseline exposure is possible. This position should be relative to future projects works that will impact each receptor;
    b. Where possible, the NMS **should** be located at the downwind of the most impacted receptor location at the same approximate elevation of the future project works;
    c. The NMS **should** be a minimum of >3 meters away from any building, structure or similar obstruction;
    d. Testing **should not** be completed during:
        - windspeeds that are greater than 5 m/s;
        - relative humidity that is greater than 95%
        - rain or fog events
        - temperatures greater than 50 degrees C
    e. The NMS **should** continuously log data for a minimum of 48 hours

    NOTE: If testing is completed during periods that exceed the meteorological conditions noted above then the periods where these events occur will be removed from the data-set. Since 48 hours of data are required by the IFC it is important to understand these limitations since monitoring stations may be required to remain in place longer to ensure that a valid sample can be collected.

NMS Assembly Instructions

The Larson Davis LxT NMS should be assembled in accordance with the manufacturers operating manual(s). The general configuration of the Larson Davis LxT NMS is illustrated in

FIGURE 1.

Figure 1 – Noise Monitoring System

The assembly of the NMS consists of the following steps:

1. Assembly the tripod and place it in accordance with siting criteria established above. Screw the grey PVC pipe extension onto the top of the tripod.

2. Open the pelican case and install the pre-charged battery (if not already in place) and connect the external battery to the LxT noise meter using the battery connector cable.

   NOTE: Ensure that all battery connections are securely attached to avoid any power disruptions. In particular, ensure that the nuts-and-bolst on the main terminal connections are tightly secured. Batteries should be charged overnight to ensure a complete charge – use a digital multimeter (provided with Weather Station) to check to DC voltage on each battery. Be sure to maintain a charge on unused batteries to protect from charge deterioration.

3. Locate the internal microphone cable (inside the pelican case) and attach it to the LxT. This is completed by inserting the internal microphone cable into the mating connector on the LxT and rotating until the keyways line up. Press the assemblies together until a small click is heard.

   NOTE: To remove the internal microphone cable from the LxT press and hold the small button located on the front of the LxT, while pulling the internal microphone cable assembly out of the LxT.

4. Attach the external microphone extension cable to the quick connect port located on the outside of the pelican case. The external microphone extension cable seats into the mating connector on the pelican case by rotating until the keyways line up. Press the microphone extension cable connector firmly into the quick connect port until a small click is heard.

5. Thread the microphone extension cable through the base of the tripod and out the top of the grey PVC pipe extension. Assembly the base and clear tube parts of the environmental shroud (Figure 2). Thread the microphone extension cable through the base, clear tube and top of the environmental shroud assembly (leaving enough cable to affix the microphone-preamplifier assembly). Pack the clear tube with dessicant and affix the top of the environmental shroud to the clear tube.

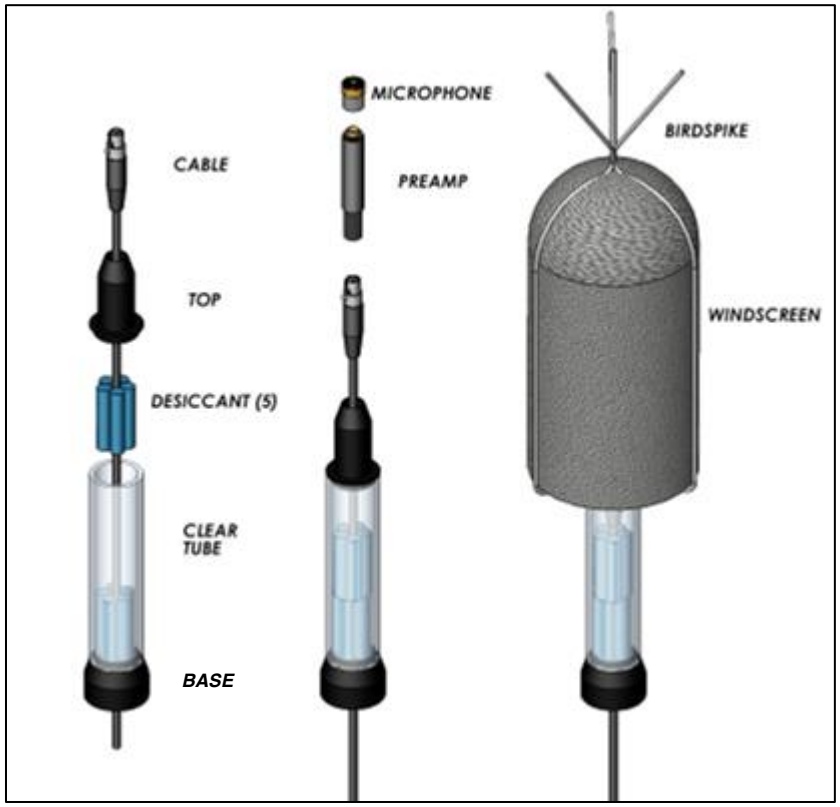


Figure 2 – Environmental Shroud Assembly

6. Remove the microphone and preamplifier from their respective storage cases. Assemble the microphone and preamplifier over a safe and secure location (i.e. over the foam inserts inside the pelican case) to avoid the potential of dropping and damaging the equipment.

   Carefully place the bottom end of the microphone over the top end of the preamplifier and gently screw the assembly together (
   Figure **3**). The microphone body should seat smoothly against the preamplifier body. DO NOT use excessive force. When removing the microphone, turn while gripping the

microphone body, not the grid cap. Carefully attach the microphone-preamplifier assembly to the microphone extension cable.

Figure 3 – Microphone-Preamplifier Assembly

7. Seat the microphone-preamplifier assembly into the top of the environmental shroud by pulling back the microphone extension cable through the base (1-3/4" of the microphone-preamplifier assembly should protrude from the top of the environmental shroud). Carefully pull back any slack in the microphone extension cable from the base of the tripod and screw the base of the environmental shroud to the grey PVC pipe extension.

8. Carefully place the windscreen and birdspike assembly over the exposed microphone-preamplifier assembly and secure in place using the set screw at the base of the windscreen (Figure 2).

   NOTE: Wind blowing across the microphone generates pressure fluctuations on the microphone diaphragm that can produce errors in the measurement. As a result, when performing measurements a windscreen should be placed over the microphone at all times. Also see Siting / Testing Requirements.

9. Secure the microphone extension cable with cable ties or electrical tape to the tripod.

10. Take multiple photographs of each monitoring location and record any field notes, including time and date of install and removal, field technician(s) name, location ID and description, security and safety issues, calibration notes (i.e. when it was completed, issues with calibration), local topographical features, weather conditions, and other sources of local noise that would contribute to baseline conditions, etc.

Calibration

The sound level meter and the acoustic calibrator should be calibrated and certified annually by the manufacturer or other independent certified acoustical laboratory. The sound level meter should be field calibrated using an acoustic calibrator, according to the manufacturer's

specifications, prior to and after each measurement. The field calibration procedures is as follows:

1. Following the completion of the LxT-NMS assembly instructions, use the CAL200 calibrator (Figure 4) to complete a field calibration. Ensure that the slide switch on the right-hand side of the CAL200 is switched to 114 dB.

2. Place the CAL200 on the LxT-NMS microphone using the microphone insert slot and turn the CAL200 on (you should hear a high pitch tone).

Figure 4 - CAL200 Calibrator

3. Turn on the Lxt-NMS by pressing the On/Off button (Figure 5). After it has completed its startup cycle, press the "Tools" button on the lower right side of the Lxt noise meter. Using the Primary Navigation Buttons select the Calibrate icon and press Enter.

4. Ensure that the LD CAL200, 114.0 dB 1 Khz is selected. This is achieved by using the Primary Navigation Buttons to scroll down and highlight the LD CAL200, 114.0 dB 1 Khz field. Press Enter to select LD CAL200, 114.0 dB 1 Khz.

5. Using the Primary Navigation Buttons select the "Calibrate" button and Press Enter. This will start the field calibration process. The unit should read close to 114 dB. Once the field calibration procedure is completed click OK to close the menu.

   NOTE: During calibration, an automatic comparison is made between the sensitivity determined by the calibration and a published value of sensitivity. If the field calibration

shows more than a 1 dB difference check all connections, ensure the CAL200 is powered up and repeat the calibration. If the same result is found there may be a problem with the equipment. Contact SENES staff immediately if this occurs.

Figure 5 - LxT-NMS Display Panel

6. Ensure that the NMS is calibrated **before** each receptor monitoring program is initiated and **after** it has been completed. It is extremely important to calibrate the unit routinely to ensure that the NMS is accurate.

NMS System Settings

The LxT-NMS can be configured manually (via the meter) or using the SLM Utility-G3 Software. Please note that Lxt-NMS was pre-programmed prior to shipment and should not require any adjustments other than the date and time.

To configure the LxT-NMS using the SLM Utility-G3 Software use the following steps:

1. Install the SLM Utility-G3 Software on your windows based computer following the command prompts.

2. Using the USB port connector, connect the Lxt to your computer. Turn on the Lxt-NMS by pressing the On/Off button. Follow the windows command prompts to install the system drivers as appropriate.

3. Double click on the SLM Utility-G3 Software icon on your desktop to start up the program

4. Refer to the SLM Utility-G3 Software manual and follow the steps to upload the settings noted in
5. Table **1** and download data from the unit**.**

   NOTE: Please ensure that the date and time are correctly set on the unit. You will be prompted when the LxT is logged into the software program (the time and date will reference you computer clock).

6. Be sure to double check that all information entered into the Settings Tabs are correct before proceeding with any sampling.

To configure the LxT-NMS manually use the following steps:

1. Turn on the Lxt-NMS by pressing the On/Off button (Figure 5). Press the "Tools" button on the lower right side of the Lxt. Using the Primary Navigation Buttons select the Calibrate icon and press Enter.

2. Press the middle Secondary Navigation Button to access the Menu. Using the Primary Navigation Buttons Select "Settings" and press the Enter button.

3. Enter the information in
4. Table **1** into each relevant Settings Tab. All other Settings Tabs are not applicable (i.e. Dosimeter 1, Dosimeter 2, etc). Use the left and right Secondary Navigation Button to

move between Setting Tabs. Use the Primary Navigation Buttons to move between fields in each Setting Tab. Press Enter to open and close each field. The Primary Navigation Buttons can also be used to enter names under the General Tab by scrolling through the available alpha-numeric characters.

Table 1 – LxT-NMS Settings Configuration

Settings Tab	Parameter	Appropriate Setting
General	Default Data file	Leave as default (Lxt_Data) or define alternate if desired; this will be the Excel file name
	Measurement Description	Blank or add description if desired
SLM	Frequency Weighting	A
	Detector	Slow
	Peak Weighting	A
	Integration Method	Linear
	+20dB Gain	Unchecked [unless in very low background area]
Ln	1	5% [suggested - user may alter]
	2	10%
	3	50% [suggested - user may alter]
	4	90%
	5	95% [suggested - user may alter]
	6	99% [suggested - user may alter]
Control	Run Mode	Continuous
	Enable Measurement History	Checked
	Time	00:15
	Interval Time Sync	Checked
	Daily Auto-Store	Never

5. Once all of the above information has been entered Press Close using the middle Secondary Navigation Button. If you have changed the settings or are completing the set-up for the first time you will be prompted to "Apply Changes?". Use the Primary Navigation Buttons to select "Yes" and press "Enter".

6. Be sure to double check that all information entered into the Settings Tabs are correct before proceeding with any sampling.

NMS Operations

1. To begin, Press the On/Off Button to power up the noise meter. Once the internal system check is complete the unit will power up and will automatically start to log data in accordance with the settings established in NMS System Settings section.

2. Allow the NMS to collect a minimum of 48 hours of data or longer if weather conditions have exceeded the thresholds noted above.

3. Once a valid sample has been collected press the Stop/Store button to end the sampling event. Press the Stop/Store button to save the file. Save the file using the Enter key.

   NOTE: This file can be viewed by pressing the Tools button and using the Primary Navigation buttons to select Data Explorer, the file you have just saved and enter to open the file.

4. Complete a post-calibration following the Calibration steps above;

5. Follow the steps outlined in the SLM Utility-G3 Software manual to connect the Lxt to your laptop and download the file onto your laptop.

   NOTE: Ensure that you store the files in folders that are marked for each individual receptor location.

6. Once the download is complete, erase the data file from the LxT.

7. Disassemble the NMS and move to the next sampling location and repeat the NMS Assembly Instructions, Pre-Calibration and NMS Operations steps.

NMS Data Analysis

1. Provide SENES with digital copies of all NMS data files and field logs and photographs on a weekly basis (or sooner).

APPENDIX A – LARSON DAVIS MANUALS

MAXXAM PASSIVE AIR SAMPLING SYSTEM (PASS) INSTALLATION AND SAMPLING GUIDE

Principles of Operation

A passive (or diffusive) sampler is a device which is capable of taking samples of gas or vapor pollutants from air at a rate controlled by a physical process such as diffusion through a static air layer or permeation through a membrane. However, it does not involve the active movement of the air through the sampler. The Maxxam Passive Air Sampling System (PASS) was developed with the support of: Alberta Environment (AENV, formerly named Alberta Environmental Protection AEP), Alberta Innovates (formerly named Alberta Research Council ARC), Clean Air Strategic Alliance of Alberta (CASA) and the national Research Council of Canada (NRC). It was designed for downward-facing installation and has been validated under extreme weather conditions. It has a durable, all-season top cover (to shelter against rain, snow and wildlife) and the user can easily install up to three samplers per shelter. The unit itself can be secured to any support system with strapping or hose clamps.

Required Equipment: Passive Air Sampling System (PASS)

At each location, two sampling units are required to be installed so that duplicate samples may be collected. A sampling unit consists of:

- 1 rain shelter;
- 1 SO_2 passive sampler;
- 1 NO_2 passive sampler;
- 1 NO_x passive sampler.

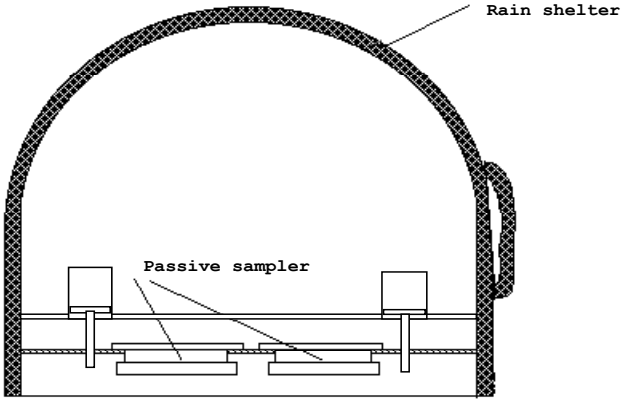


Figure 1 – Cross-Section of Rain Shelter

Installing passive samplers

Each rain shelter will house one (1) NO_x, one (1) SO_2, and one (1) NO_2 passive sampler. To install the PASS, complete the following steps:

1. Find a suitable location or supporting structure that can be used to secure the rain shelter using hose clamps (or similar) so that the underside of the rain shelter faces down towards the ground (see Figure 2). The bottom of the rain shelter should measure 1-3 meters above the ground (see Figure 3).

Figure 2 – Rain Shelter In Place

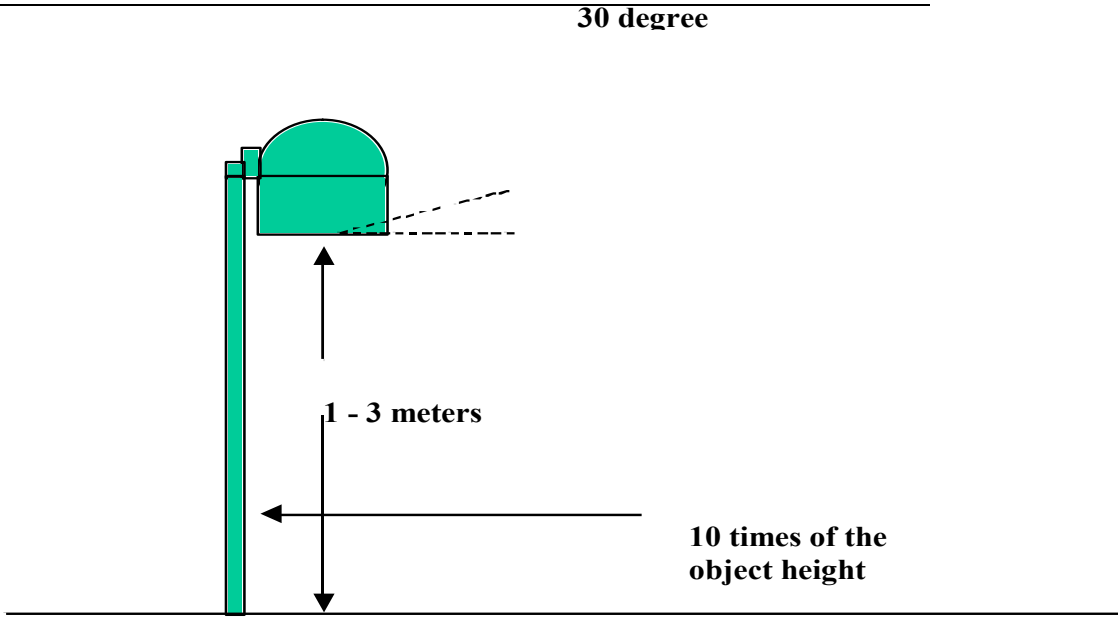


Figure 3 - Height Above Ground

NOTE: Monitoring locations should not be close to roadways. The distance between the site and the roadway should be more than 10 m. Monitoring site should be located away from nearby obstructions such as buildings, trees, etc. The ideal monitoring site should be more than 20 m from the nearest tree canopy (drip line).

2. Using latex or nitrile gloves, remove one of the passive samplers from its metal protective container and the re-sealable plastic bag (Figure 4). Store the plastic bag inside of the container for future re-use. When handling a passive sampler:

   IMPORTANT: Do not to touch the diffusion barrier (the white centre); hold the sampler by the plastic edge (see Figure 4). Do not let the passive sampler contact the ground.

   Carefully remove the protective plastic cap on the passive sampler. Keep the plastic cap with the metal protective container also.

Figure 4 – Passive Sampler Re-Sealable Bag and Metal Container

3. Holding the passive sampler (colour side facing toward the ground), push up any of the-three buttons on the rain shelter and slide the sampler into the centre of the rain shelter (see Figure 5). Make sure that the button falls back down after the passive sampler has moved to the centre.

Figure 5 – Installation of Passive Samplers

4. Record the exposure starting date and time of day on the field sampling sheet provided.

5. Repeat steps 2-4 for the remaining two (2) passive samplers.

   IMPORTANT: Do not open passive samplers labelled "Blank". Keep stored until the others are to be sent for analysis.

Removing passive samplers

1. Record the exposure end date and time of day on the field sampling sheet provided. The time should be about 30 days or 720 hours.

2. Holding the edge of a passive sampler, slide it away from the centre of the rain shelter to remove it.

3. Find the corresponding metal container for the passive sampler. Place the plastic cap back on the passive sampler and put it back into the plastic bag. Finally, place into the protective metal container and seal the container with Teflon tape to preserve sample integrity.

4. Fill out a Maxxam chain of custody form for all samples, and forward all passive samplers, including those labelled "Blank" to the lab. Samples should be sent to the lab as soon as possible after retrieval.

Storing unexposed passive samplers

1. Passive samplers that are not installed/exposed can be stored at room temperature for no longer than one month OR in a refrigerator at 4^{o}C for no longer than 3 months.

Passive Sampling Rate Calculation

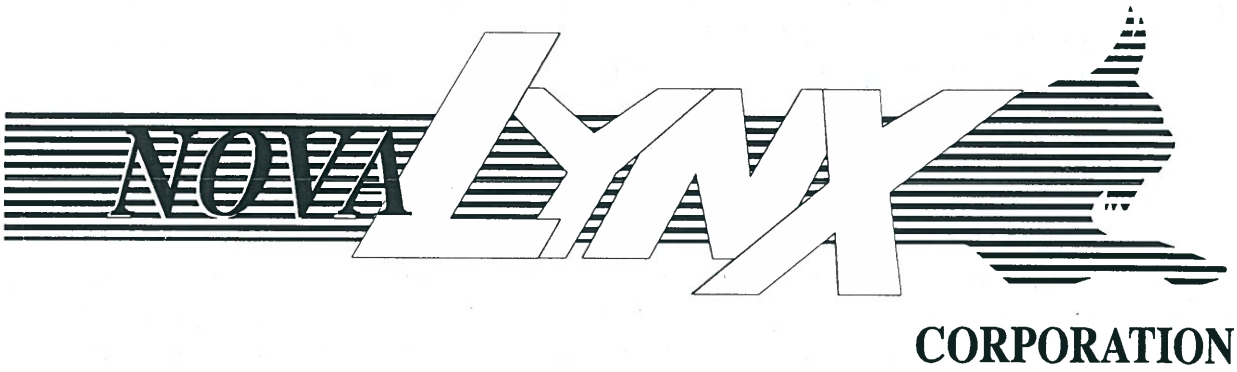
1. The passive sampler's sampling rates depend on many factors such as temperature, relative humidity (RH), wind direction, wind speed, sampler's structure, and collection media. An equation, which accounts for variations in temperature, relative humidity, and wind speed, is used by the lab to calculate sampling rates. Collect the meteorological parameters from the local meteorological station from the beginning to the end of the sampling period and provide them to the SENES for submission to the lab.

   NOTE: These sampling rate calculations will be completed by Maxxam.

NOVALYNX CORPORATION

INSTRUCTION MANUAL FOR MODELS

110-WS14TM 5 FT TRIPOD & THREADED MAST
110-WS16TM 5 FT TRIPOD & SWEDGED MAST
190-510 5 FT TRIPOD TOWER
190-520 10 FT TRIPOD TOWER



REVISION DATE:09/99

Receiving and Unpacking

Carefully unpack all components and compare to the Packing List. Notify NovaLynx Corporation immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. Damages to equipment sent via Parcel Post or UPS require the consignee to contact NovaLynx Corporation for instructions.

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If equipment is to be returned to the factory for any reason, call NovaLynx between 8:00 A.M. and 4:00 P.M. Pacific Time and request a Return Authorization Number (RA#). Include with the returned equipment a description of the problem, and the name, address, and daytime phone number of the sender. Carefully pack the equipment to prevent damage or additional damage in the return shipment. Call NovaLynx for packing instructions in the case of delicate or sensitive items. If packing facilities are not available take the equipment to the nearest Parcel Post, UPS, or freight service and obtain assistance with the packaging. Write the RA# on the outside of the box.

Warranty

NovaLynx Corporation warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. NovaLynx Corporation's obligations under this warranty are limited to, at NovaLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall NovaLynx Corporation's liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by NovaLynx Corporation, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

Address

NovaLynx Corporation
4055 Grass Valley Highway, Suite 102
Auburn, CA 95602
Phone: (530) 823-7185
Fax:(530) 823-8997
E-Mail: nova@novalynx.com
Website: WWW.NOVALYNX.COM

5 FOOT TRIPOD TOWER
MODEL 190-510

NovaLynx Corporation provides a five foot high tripod for mounting meteorological instruments at outdoor locations. The tripod is normally used with a pipe extension to give a total height of about 8 feet. The design of the tripod includes a pipe collar and lower support allowing adjustment of the mast for various heights. The various meteorological instruments normally include mounting hardware. Whenever possible, NovaLynx provides special mounting hardware for customized applications. In areas where high velocity winds are expected, NovaLynx recommends using a guy wire kit and earth or roof anchors to tie down the tripod. Mounting bases are normally the responsibility of the customer. Some assistance from NovaLynx is available in determining the proper method of installing the tripod for each customer. For assistance in the actual installation of the tripod, NovaLynx recommends contacting a local tower or antenna installation company.

The 5 foot tripod tower is similar in construction and use as the ten foot tripod, Model 190-520. The manual for the ten foot tripod is included here for general information along with drawings of typical five foot tripod elevations.

TABLE OF CONTENTS

SECTION NUMBER		PAGE NUMBER
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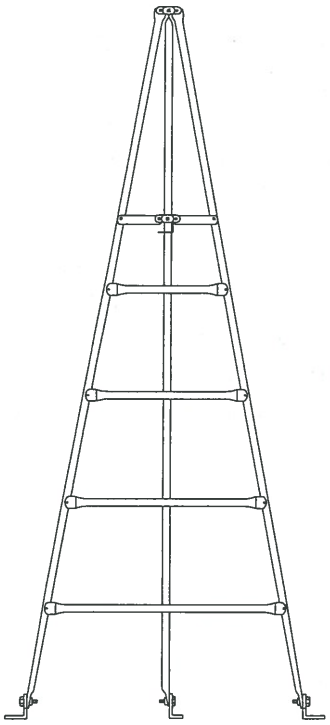
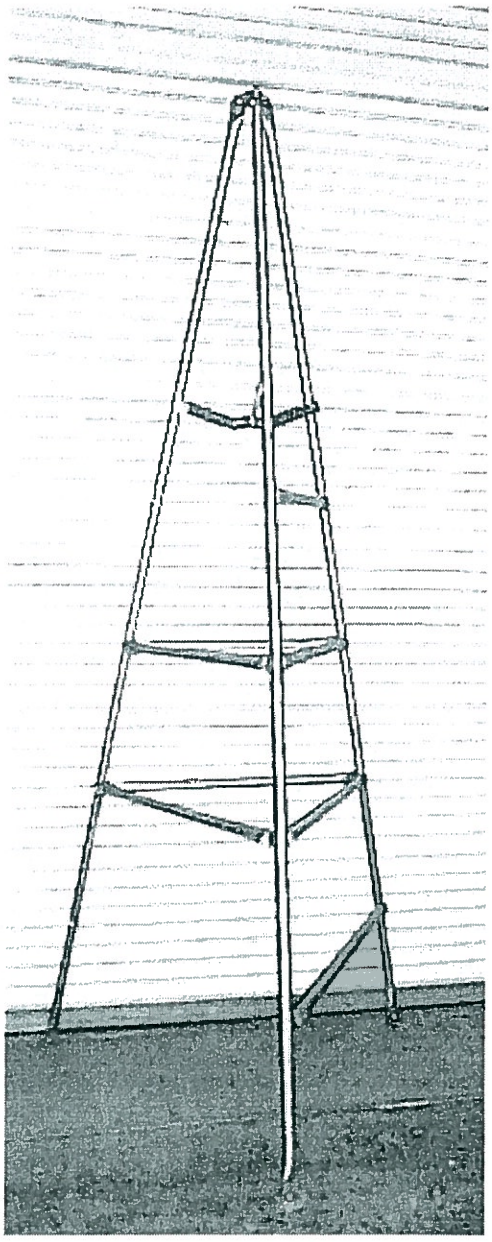
2.0	SPECIFICATIONS	2
2.1	SPECIAL ACCESSORIES	3
3.0	INSTALLATION	3
4.0	GROUNDING KITS	5
5.0	DRAWINGS	5

EQUIPMENT CONFIGURATION DRAWING



10 FT TRIPOD TOWER



Model 190-520

10 Ft Tripod Tower
Model 190-520

1.0 Introduction

1.1 NovaLynx provides a ten foot high tripod tower for use as a low cost and portable instrument tower. The tower is primarily for mounting wind sensors at low levels or on roof tops but it can also support other instruments as well. A removable and adjustable mast is inserted into the top of the tower and is fastened into place using the two mounting collars. For telemetry applications the tower may be used to mount a radio antenna.

1.2 The tripod tower features a ladder on one side to facilitate climbing of the tower for installation and service of the tower mount equipment. The ladder pieces and the cross braces are bolted onto the tower legs prior to installation of the tower. For portable applications, the cross braces can be removed and the tower legs can be folded inward allowing easy transporting of the tower. The tower has one hinged set of cross braces and the top mounting collar is the second hinge point.

1.3 NovaLynx tripod towers are constructed of steel tubing for durability and strength. For additional strength and stability, a guy kit is recommended for especially in locations with high winds and for masts that extend above the tower by ten feet. Locations that are exposed to lightning require a grounding kit. Commonly used accessories are listed below. Special accessories may be ordered separately.

2.0 Specifications

Height:	10'
Materials:	Galvanized Steel Tubing
Crossbracing:	Horizontal bars, 3 sets 2 removable, 1 hinged
Mast Mounting:	Fixed Collar Clamps 1 at top of tripod and 1 at first horizontal bar
Base Mounting:	Angled Foot Brackets with 3 Bolt Holes at 1 3/8" Centers
Base Diameter:	58 1/2"
Guying:	Required With 10' Mast
Weight/Shipping:	30 lbs/30 lbs (14 kg/14 kg)

2.1 Special Accessories

Model 190-310	5' Mast 1" Aluminum Pipe (1.34" O.D.)
Model 190-320	10' Mast 1" Aluminum Pipe (1.34" O.D.)

TRIPOD GUY KITS WITHOUT ANCHORS

Model 190-210	20' Height, Maximum

EARTH ANCHORS

Model 190-211	15" Auger Style, Set of 3
Model 190-213	48" Heavy Duty Style, 1 pc

ROOF ANCHORS

Model 190-212	5/8"x 14" Eye-bolt and Plates Set of 3

TRIPOD GROUNDING KIT

Model 190-110	5' Copper Cable, 1 Ground Rod(8'), & Clamps Attached to each Tripod Leg

3.0 Installation

3.1 Installation of the tripod tower involves opening the tower legs to their maximum separation, attaching the cross braces, bolting the tower feet onto the mounting base, and installing any accessories.

3.2 Upon receipt and initial inspection of the tower, remove the tower and the cross braces from the shipping container. Check to ensure that all of the pieces need are present. There should be six cross braces and two ladder pieces. Also included are the bolts and nuts for mounting the braces onto the tower legs. The mount feet are permanently attached to the tower legs. The two mast collars should have three fastening bolts on each collar.

3.3 The supporting base or foundation should be prepared prior to the installation of the tripod tower. For roof mounted towers, a raised wooden platform is often used to bolt the tripod tower to the roof. The wooden platform must be attached to the roof with the type of hardware that is suited to the roof construction. Ground mounted tripods may be bolted onto concrete foundations or onto wooden platforms. Wooden platforms that are ground mounted must securely anchored to prevent the tripod from tipping over in high, gusty wind conditions. Concrete foundations may be constructed with anchor bolts place into the concrete. Using the tripod tower as a pattern, attach the anchor bolts onto the tripod feet and then place the tripod onto the wet cement. For orientation of wind direction sensors, it is recommended that two of the tower feet be set to be in line with North. Check the vertical level of the

tripod and make adjustments while the cement is still wet. For permanent installations the lower portions of the tower legs and feet may be placed directly into the cement.

3.3.1 If there is space available and local conditions will allow it, make the concrete foundation large enough to provide room to walk around the tower. This will ease the servicing of tower mounted data loggers and junction box mounted equipment.

3.4 Prior to the installation of the tripod tower, check to ensure that all hazardous conditions have been removed from the area, especially overhead hazards. If necessary relocate the tripod tower to avoid power lines and similar hazards.

WARNING: Do not attempt to climb the tripod tower until it has been firmly bolted onto the foundation.

3.5 After the tripod tower has been bolted onto the foundation, install the sensors and accessories. If the required height of the wind sensor is known, the wind sensor's mast may be placed into the mounting collars and set to its height before setting the tower onto the base. This can save having to carry the mast up the side of the tower.

3.6 Guy wires and grounding kits should be installed prior to the installation of any equipment. Do not work on a tower that is not properly grounded and halt all work at the first indication of an approaching storm.

3.7 The second mounting collar is located a distance of three feet below the top mounting collar. For best results and greatest stability, the wind sensor mast should be set into both mounting collars. Selection of the proper mast should allow for this three foot length that will be below the top of the tower.

3.8 Junction box mount equipment should be placed onto the tower in the most convenient location. Usually, the junction box is located on the North side of the tower away from the intense sunlight. When placing the tower onto the foundation be sure to keep in mind where the ladder braces are in relation to the junction box location. Avoid placing the junction box over the ladder braces to prevent the service technician from having to climb over the junction box to reach the wind sensors.

3.9 Since the tripod tower legs are slanted, instruments that must be mounted level must use mounting fixtures that can be adjusted to compensate for the slant of the legs. The tower legs have a slope of about 80 degrees.

3.10 During the tripod installation, do not drill any holes into the legs at any place for any reason. Modification of the tower structure may cause an unsafe installation. Please contact NovaLynx before making any structural changes to the tripod. When the junction box mounting brackets and the sensor mounting hardware are being attached onto the tripod, avoid over-tightening the bolts. Do not deform the tripod legs by tightening the bolts too much. For locations with high or constant winds use double nuts or jam nuts to secure the mounting hardware. For instruments that are mounted at the top of the tower or on a tall mast, place the mounting bolts into each hole from the ground side. Should the bolt become loose it will fall out leaving a hole that should be noticeable during visual inspections.

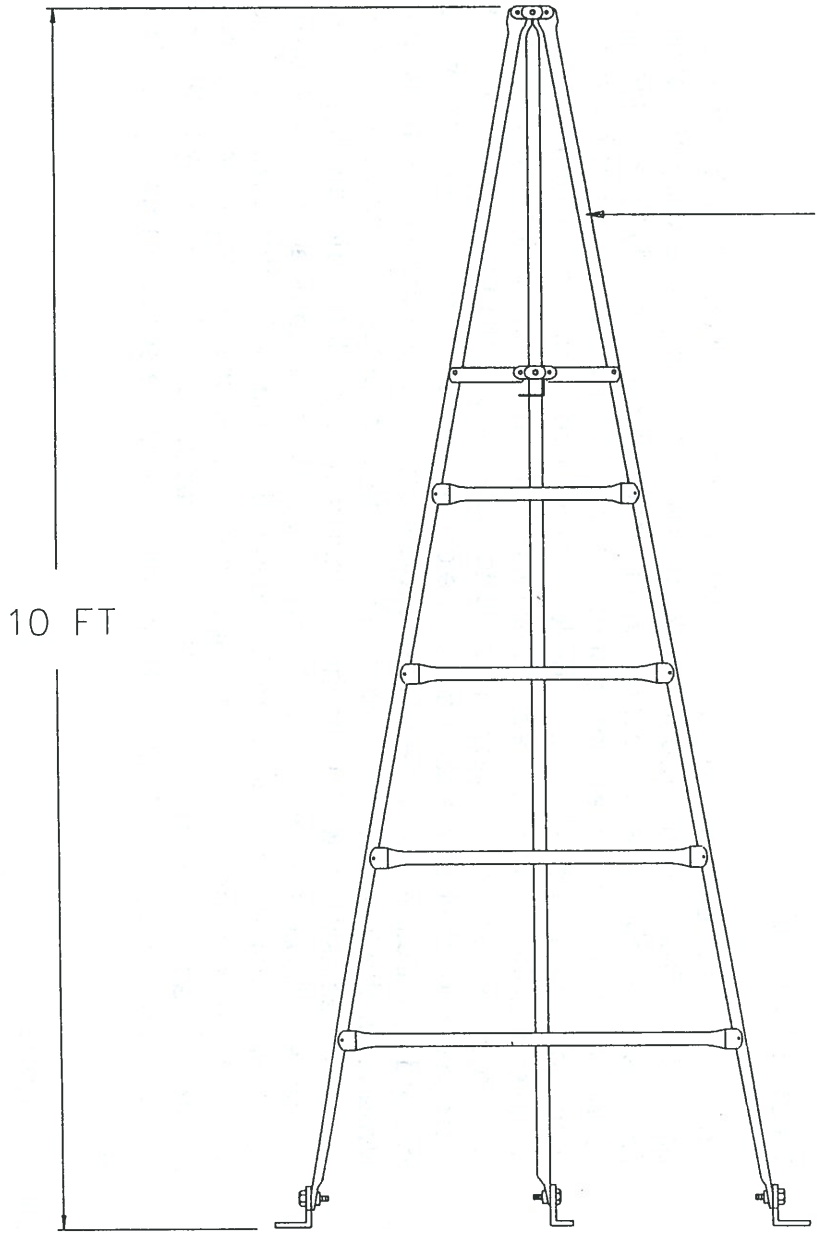
3.11 Upon completion of the sensors' installation, route the cables down one of the tripod legs. Fasten the signal cables to the leg using ultra-violet resistant or stainless steel cable ties. Cable ties should be placed at two foot intervals. Any AC voltage power cables used on the tower should be routed down a tower leg separate from the sensor signal cables. Some installations may require that power cables be housed in rigid conduit. Refer to local codes to determine whether or not conduit is needed on the tower.

4.0 Grounding Kit

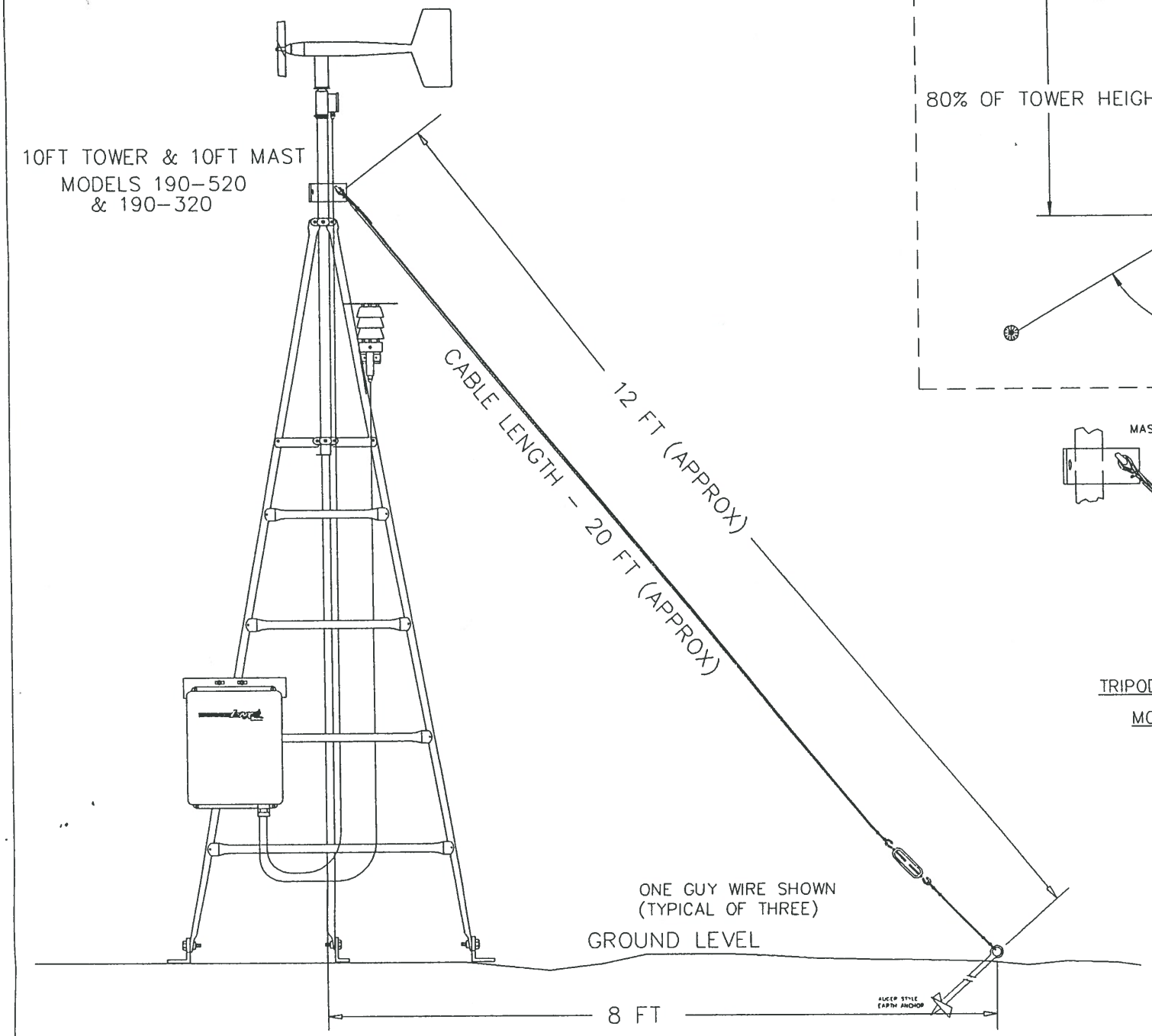
4.1 NovaLynx provides the latest technology in tower grounding kits for lightning protection. The standard grounding kit for tripod towers provided by NovaLynx features a five foot copper copper cable, an eight foot long ground rod, and clamps for both ends of the cable. The ground rod is placed as close as possible to the tripod foundation and adjacent to the leg that is to be grounded. The ground rod is driven into the soil with only about two to three inches of the end exposed above the ground's surface. A clamp is used to fasten the cable to the tower leg. A second clamp attaches the other end of the copper cable to the exposed end of the ground rod. Both ends of the copper cable must be bare if the wire is insulated. Whenever the tripod tower is surrounded by taller structures, such as trees, the tower is used as the down lead to the grounding system. If the tripod is the tallest structure in the area a lightning rod may need to be installed near the tripod tower location. Whenever possible the lightning rod should be located away from the tripod tower and installed on a separate mast. Regions that experience severe lightning may need to install a more sophisticated type of grounding kit. Please contact NovaLynx for additional information regarding a superior tower grounding kit.

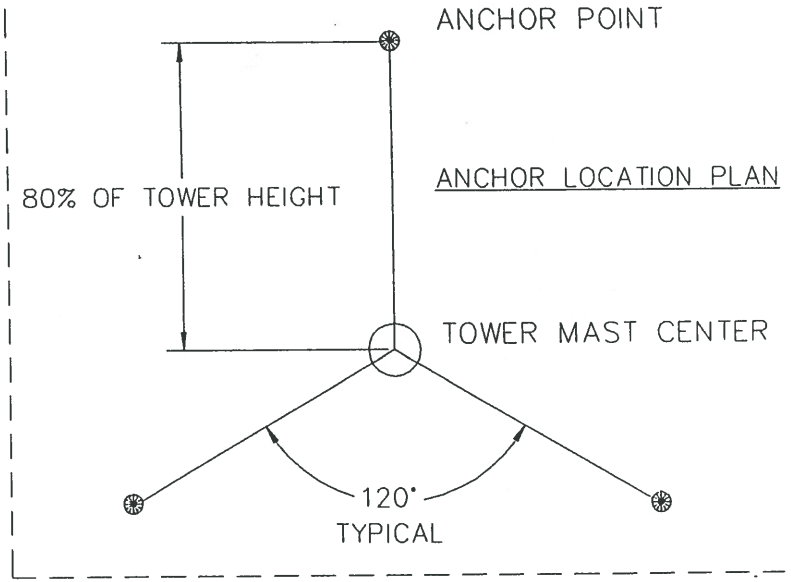
5.0 Drawings

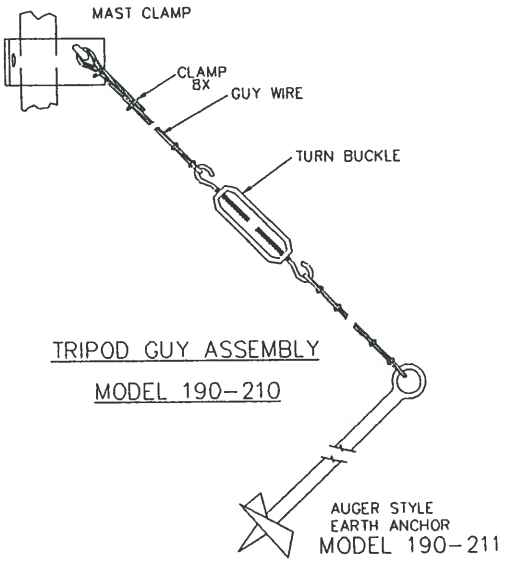
5.1 The following pages include dimension drawings and typical installation elevation drawings for the tripod tower. Refer to these drawings for assistance in the installation of the tripod and its associated hardware.



LYNX CORPORATION			C
TITLE: OUTLINE, 10 FT TRIPOD TOWER MODEL 190-520			
MODEL USAGE 190-520			SHEET 1 OF 1
BY RGN	SCALE 1:1	DWG. NO. 960703	
DATE 7-18-96			







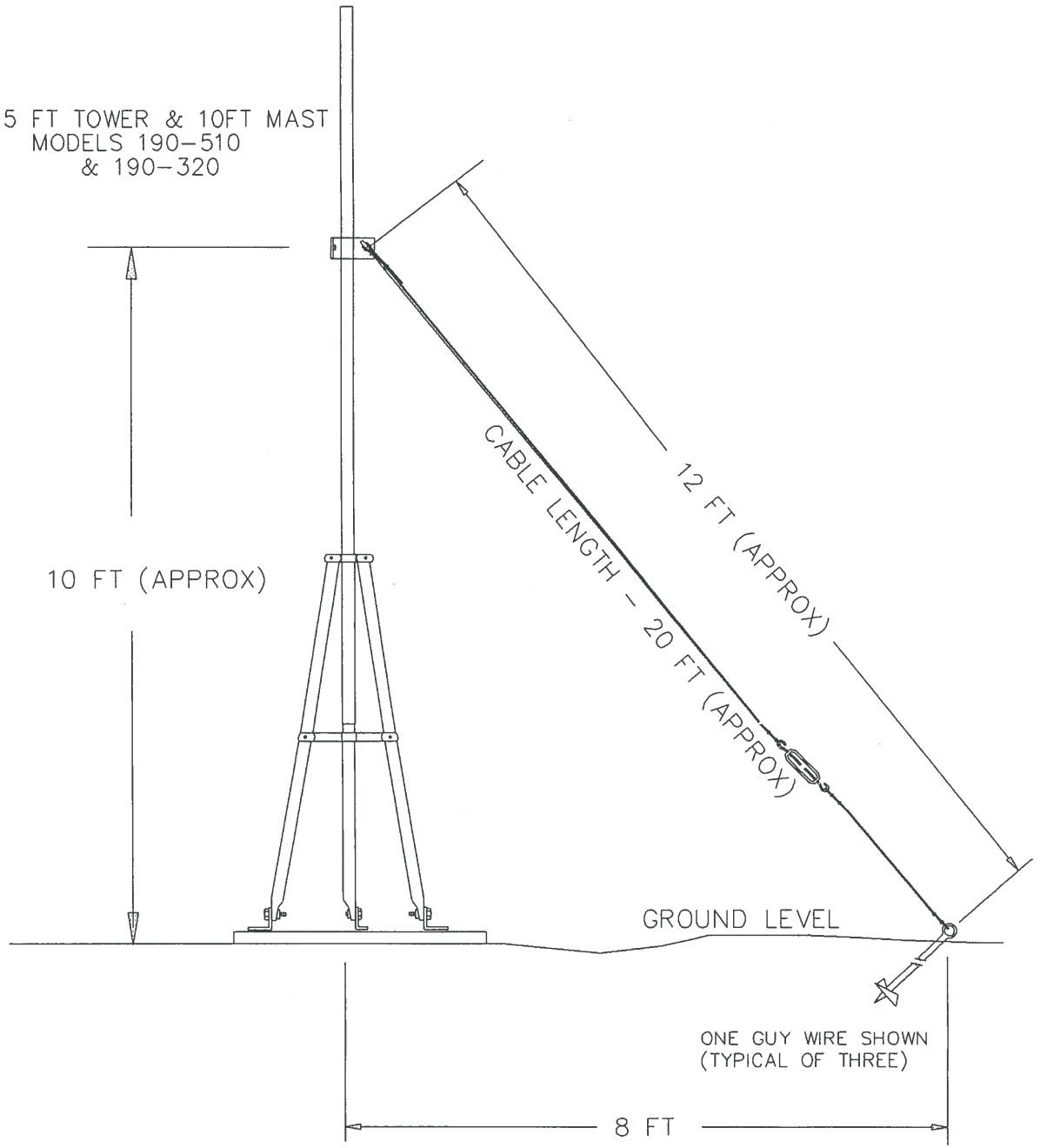
DRAWING NOT TO SCALE.

NOVALYNX CORPORATION

C

TITLE ASSEMBLY, 10FT TRIPOD
TOWER WITH GUY KIT

MODEL USAGE 190-520			SHEET 1 OF 1
BY RGN	SCALE	DWG NO.	940913
DATE 9-17-97	NONE		



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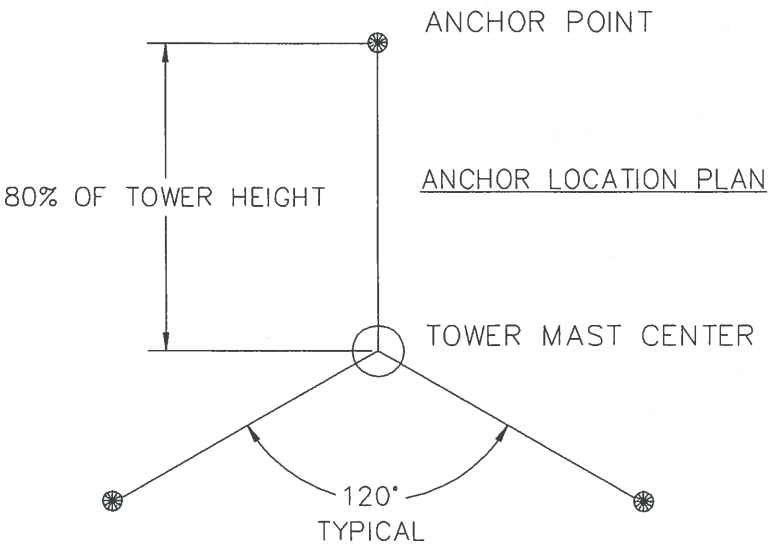
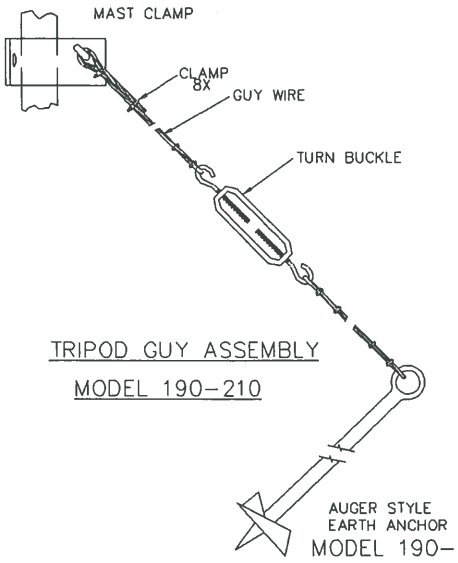




TRIPOD GUY ASSEMBLY
MODEL 190-210

AUGER STYLE
EARTH ANCHOR
MODEL 190-211

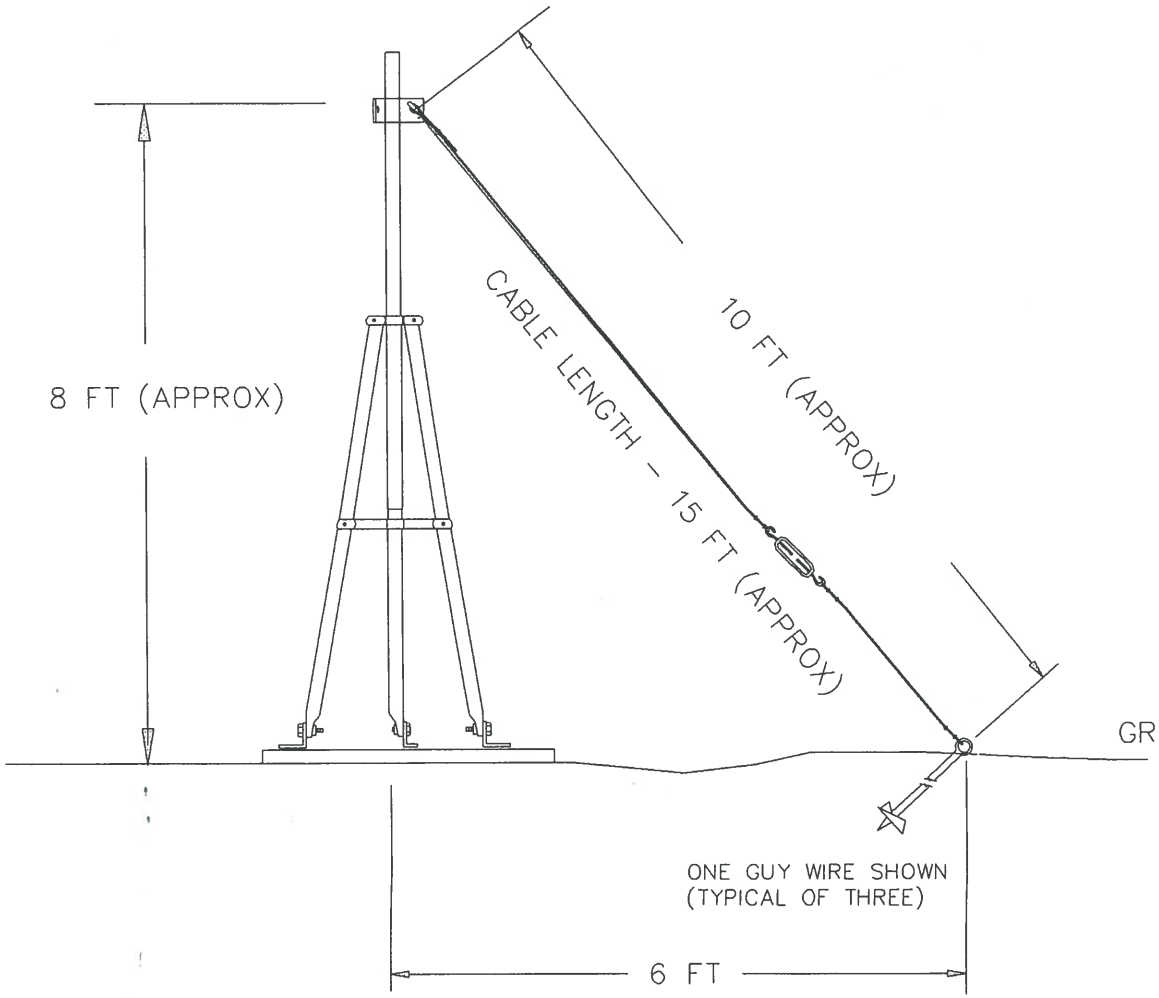
NOVA LYNX CORPORATION

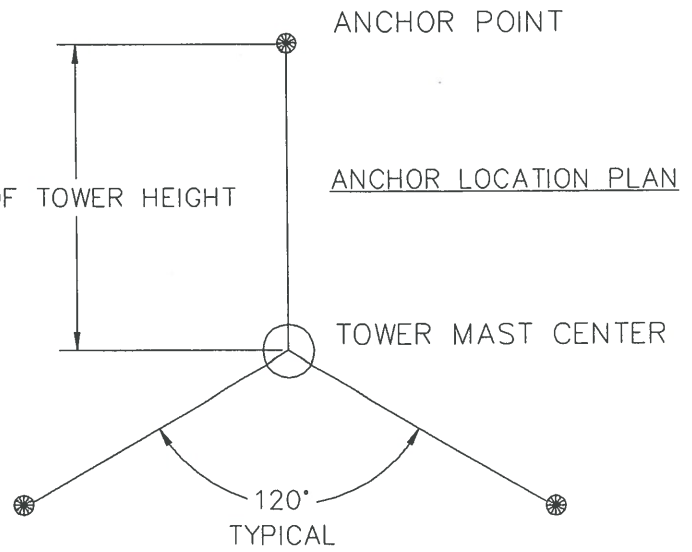
C

TITLE
ASSEMBLY, 5FT TRIPOD
TOWER WITH GUY KIT

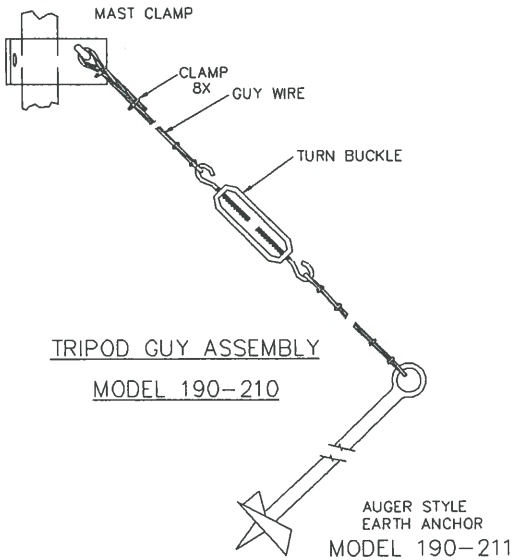
MODEL USAGE 190-510			SHEET 1 OF 1
BY RGN	SCALE	DWG. NO.	940914
DATE 9-17-97	NONE		

5 FT TOWER & 5FT MAST
MODELS 190–510
& 190–310





ANCHOR LOCATION PLAN



TRIPOD GUY ASSEMBLY
MODEL 190–210

DRAWING NOT TO SCALE.

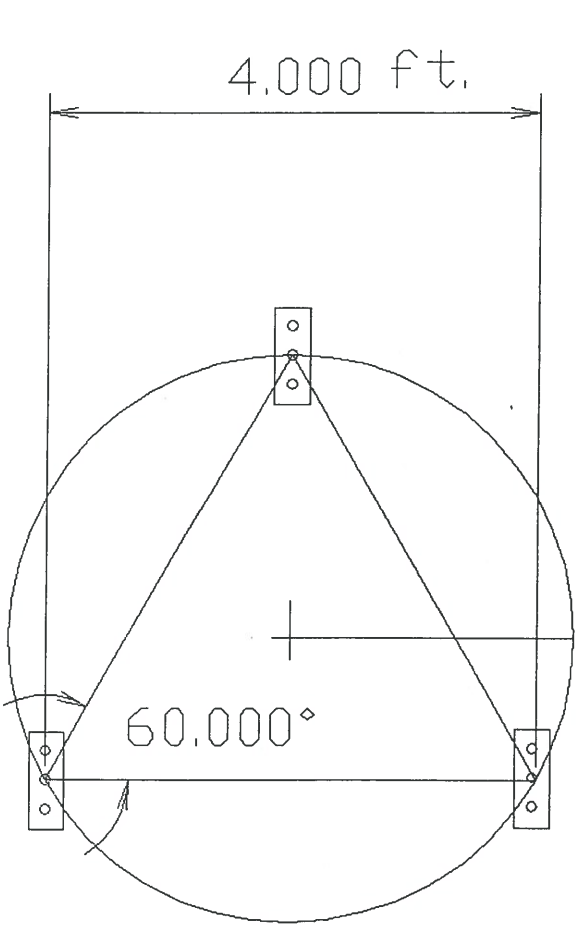
NOVA LYNX SYSTEMS INC

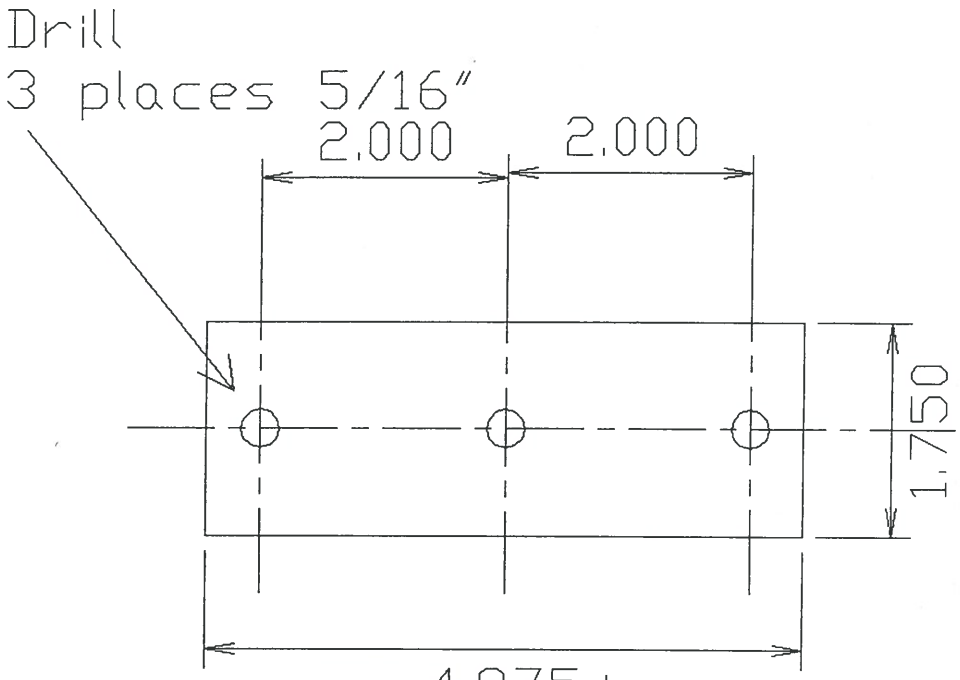
C

TITLE ASSEMBLY, 5FT TRIPOD
TOWER WITH GUY KIT

MODEL USAGE 190–510			SHEET 1 OF 1
BY RGN	SCALE	DWG. NO.	940915
DATE 9-17-97	NONE		

FIVE FOOT TRIPOD FOOT PRINT

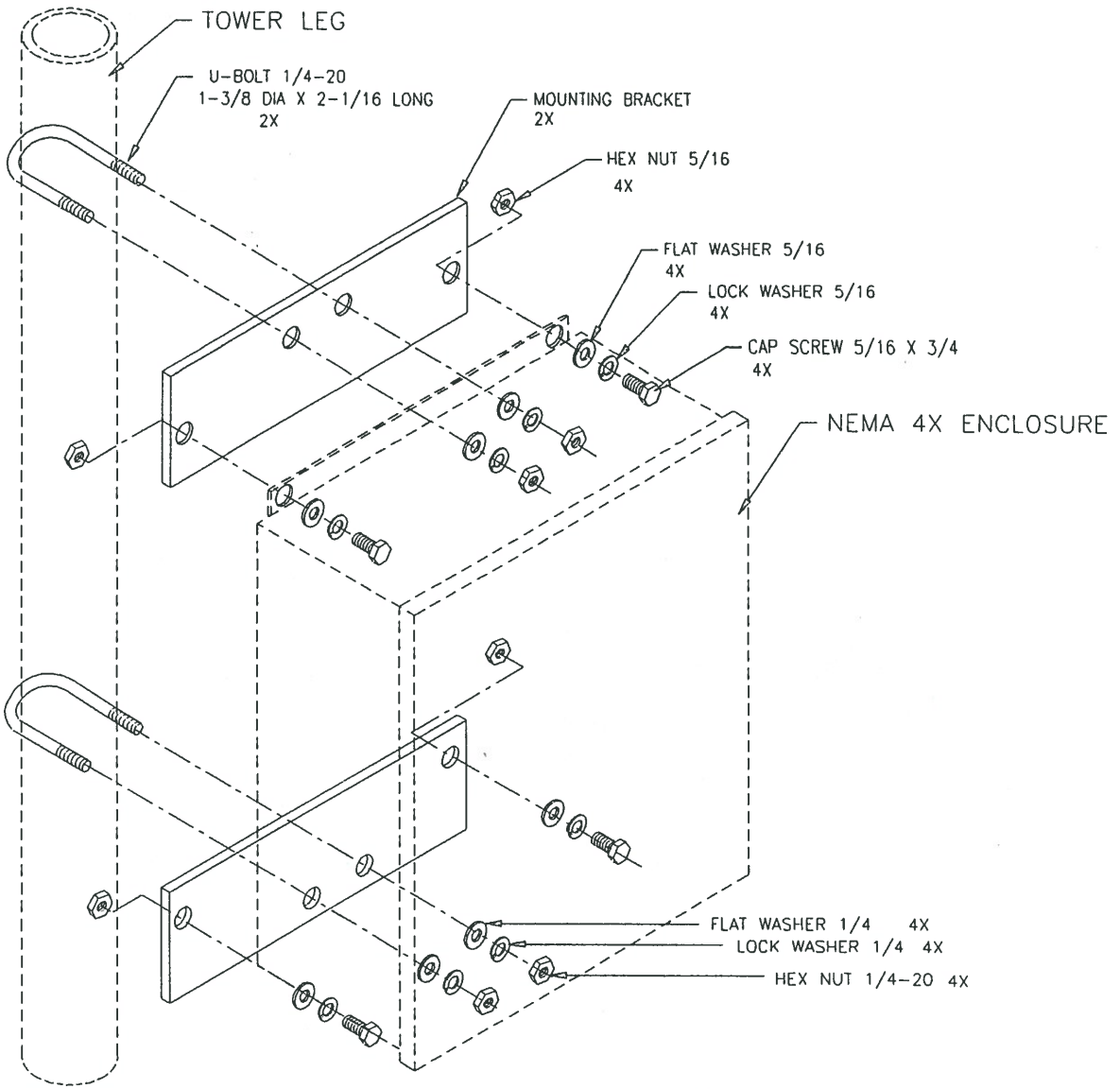




Bracket Foot Print

Radius= 2.309 ft.=2ft. 3-11/16in.

NovaLynx Corporation P.O. Box 240 Grass Valley, CA 95945	
06 Jan 2005	
by cna	PN 190-510



TYPICAL VIEW

NOTE – 1. BOTTOM BRACKET IS INVERTED COMPARED TO TOP BRACKET.
2. ROTATE BOX ON TOWER LEG SO THAT BACK OF BOX IS PARALLEL TO THE TWO OPPOSITE TOWER LEGS.

NOVA LYNX CORPORATION

C

TITLE ASSEMBLY, INSTALLATION ENCLOSURE, MODEL 395 SERIES

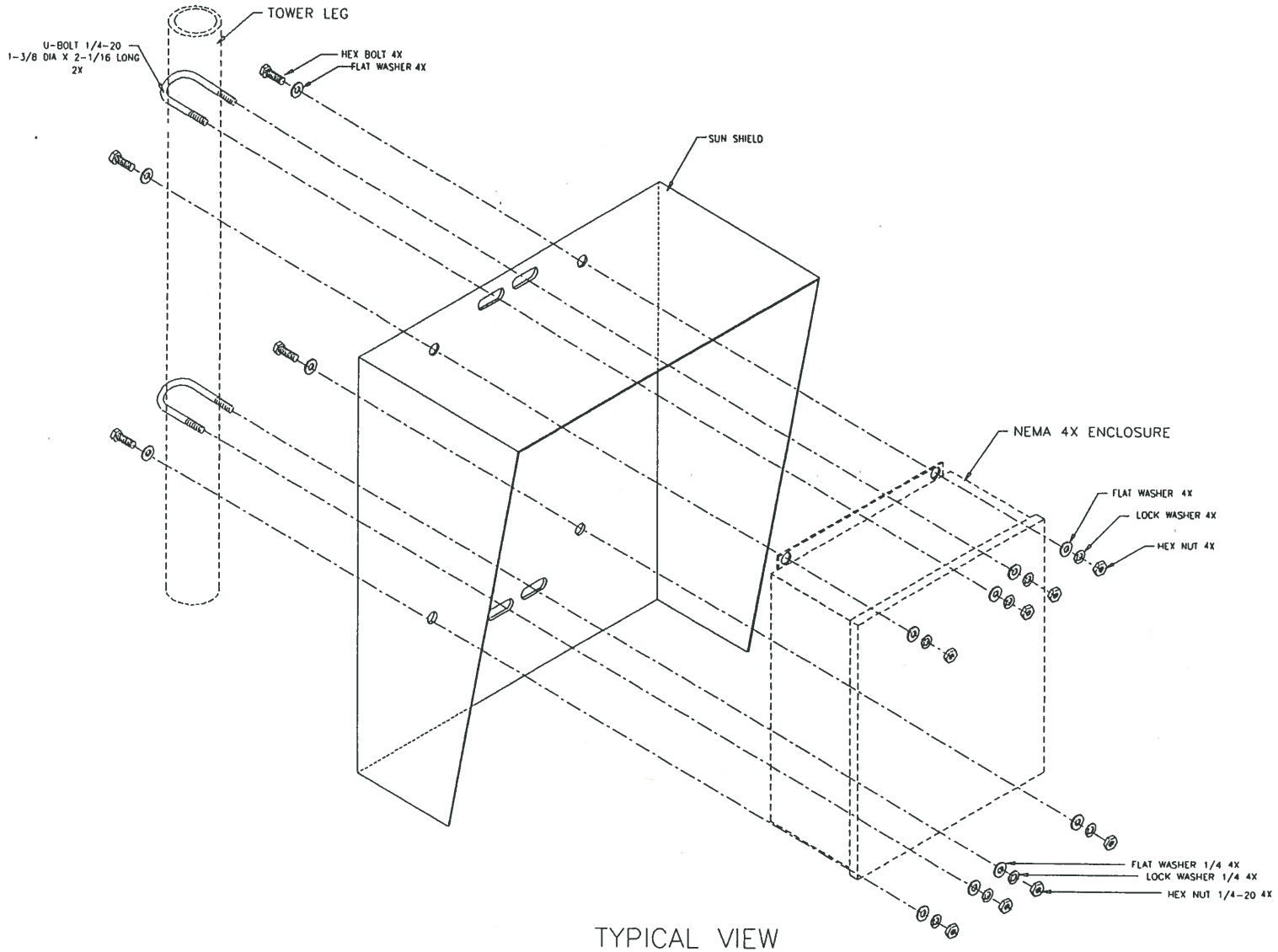
MODEL USAGE

SHEET 1 OF 1

BY RN

DWG. NO. 930306

DATE 3-04-93



TYPICAL VIEW

NOTES: 1. ROTATE BOX TO CENTER ON TOWER LEG.
2. BACK OF SUN SHIELD SHOULD SOUTH.
3. JBOX HARDWARE IS SIZED TO FIT BOX.

LOVE LYNX CORPORATION	C
TITLE: ASSEMBLY, INSTALLATION, NEMA 4X ENCLOSURE WITH SUN SHIELD	
MODEL USAGE	SHEET 1 OF 1
BY RN	DWG. NO. 970302
DATE 3-05-97	

NOVALYNX CORPORATION

MODEL 110-WS-25
MODULAR WEATHER STATION

INSTRUCTION MANUAL

V.9-12 REVISION DATE: Sept 2013

Receiving and Unpacking

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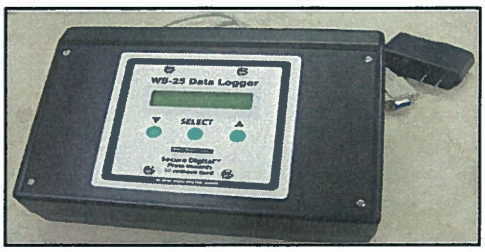
Address

NovaLynx Corporation
4055 Grass Valley Highway, Suite 102
Auburn, CA 95602
Phone: (530) 823-7185
Fax: (530) 823-8997
Email: nova@novalynx.com
Website: www.novalynx.com

MODEL 110-WS-25
EQUIPMENT CONFIGURATIONS AND IDENTIFICATION

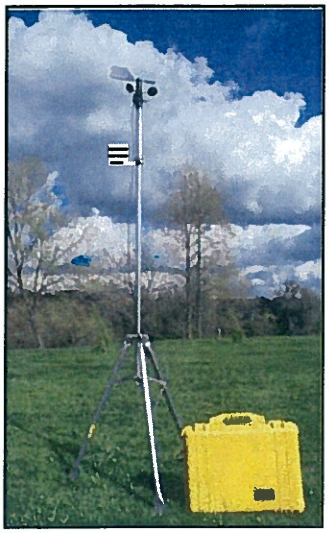
110-WS-25
Modular
Weather
Station



110-WS-25DL-D Desktop Data Logger with Display
with AC Power Adaptor and Serial Output Cable

110-WS-25N
Modular
Weather Station
shown with optional
solar panel charger

110-WS-25DL-N Data Logger in NEMA-4X Enclosure
With 12v 7Ah Battery & AC Charger, surge protection



110-WS-25P
Portable
Weather Station

110-WS-25DL-PA or PB Data Logger in carrying case
With 12v 7Ah Battery & AC Charger

NovaLynx Corporation

Model 110-WS-25 Modular Weather Station
Instruction Manual

1.0 INTRODUCTION

The **110-WS-25 Modular Weather Stations** are meteorological systems designed to be a "user friendly" solution for data storage and real-time monitoring of weather conditions.

The Manual covers all three versions, Desktop, Nema and Portable, the Data logger and general operation is the same on all versions

The standard sensor package includes 6 weather parameters: Wind Speed and Direction, Temperature and Relative Humidity, Barometric Pressure, and Precipitation, (additional optional sensors can be added), a 5-Foot Tripod and 5'ft. Vertical Mast for sensor mounting, and a Data Logger with LCD Display. The portable systems have a 3 ft tripod with 6 foot mast and, pressure and rain are optional.

No computer is required for setup and viewing data. A simple menu interface using the LCD display and three front panel buttons makes setup easy.

Data is recorded directly to a Secure Digital (SD™) card, providing convenient data downloads and storage for many months of data. The data logger is compatible with standard SD cards up to 2GB. Logging at 1 minute intervals, a 2GB card will store over 5 years of data.
A new file is created and saved to the card each day.

An RS-232 Serial Output is standard and allows real time viewing of the data on a PC, with any terminal emulator program, ex. HyperTerminal, Putty or the Optional 110-WS-25STR Graphical Display Software.

Using the stored recorded data is simple. The SD card is removed from the logger, then inserted into the SD card reader, then plug it in to the USB port on your computer (Windows, Macintosh, and Linux) and will then show up as a drive. To view and graph the data, click on the file corresponding to the day of interest. Microsoft Excel, OpenOffice.org, or any spreadsheet program can be used to view, graph, and analyze your data.

Typical Data Sample.....

2013-07-15 13:51:50,4.2,10.1,190,,,,,,,,0.04,223,12.14,,,,57.807,67.471,28.700,,192

NAVIGATION

The Ws-25 data logger's easy-to-use interface includes a 16 character by 2 line backlit LCD screen, which displays current information and is used for configuring the data logger. A simple menu-driven interface using the LCD and three front panel buttons makes setup easy. A bright backlight makes the data logger easy-to-use at night. A Secure Digital (SD™) card slot makes recording and accessing data easy. **(See Figure below)**

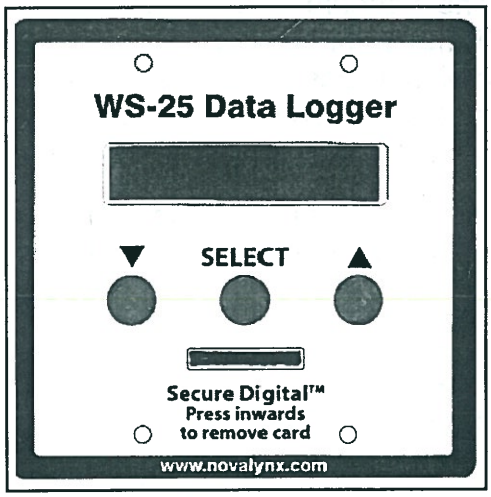
BUTTONS

▼ Scrolls through display screens and allows user setup menus. Moves values in the negative direction.

SELECT: Press to enter 'Setup' menu

▲ Scrolls through display screens and allows setup menus. Moves values in the positive direction.

All buttons respond to a single press; holding a button will not cause multiple actions to occur.



SECURE DIGITAL™ CARD SLOT

The wind data logger has a spring-loaded memory card slot. To insert a Secure Digital™ (SD™) card, place the card face up into the slot on the front panel and press the card inwards until the card clicks into place. To remove card, press the card slightly inward and the card will release.

The card should not be removed by pulling it out without first pressing it inwards. If a card is pulled out in this manner, both the memory card and the card socket may be damaged.

WS-25 System General Start Up and Operation

The WS-25 Weather Station has been set up and configured for the Six Standard Sensors, Speed, Direction, Temperature, Humidity , Barometric Pressure and Rainfall .
It has been shipped for A Plug and Play Operation.

1. Set up the tripod and vertical mast, and secure it.
2. Mount the sensors Wind, RH/T , Rain Gauge on the tripod.
3. Connect the sensor cables wires to the Data logger.
4. Apply power the WS-25 Logger.
5. Confirm and or set the correct date and time.
6. Scroll thru the Channels to Verify the proper readings on the display
7. Insert the SD memory into the logger *(Data is logged once a minute , this can be changed in needed)*
8. An RS-232 Serial Output is available for direction connections to a P.C.
9. Done .

Refer to the " Quick Start " instruction Booklet for Sensor wiring connections, Power Connections and other special information.

CONFIGURATION AND OPERATION

On the data logger display, the primary menus are: **Main Setup Menu**, **Wind Channels**, **Analog Channels** , and **Counter Channels**. Sub-menus of the **Main Setup Menu** are: **Date Setup**, **Time Setup**, **Anemometer Setup**, **Wind Vane Setup**, **Log Interval**, **Counter Setup**, **Analog Setup**, **Channels to Log**, **RS-232 Setup**, **Wind Vane Setup**, **Site Name Setup**, **Sync. Setup**, and **Restore Defaults**. The wind data logger has three keys: q which moves backwards or down (depending on the screen); **SELECT** which selects, sets, or moves to the next character; and p which moves forwards or up (depending on the screen).Since the WS-25 logger has been pre-configured there is no need to go into the sensor setup menus .

SETTING THE TIME AND DATE

Using the 'Time' and 'Date' screens, one can both view and set the current date and time. The wind data logger incorporates a real-time clock that keeps accurate time while power is disconnected. The clock does not automatically adjust for daylight savings; however it does automatically adjust for leap years. The date format used throughout the wind data logger is YYYY-MM-DD.

See the **CONFIGURATION AND OPERATION Table** Below for sample screen shots and detailed instructions for changing time and date. The same method is used with all data logger setup screens.

	Display Screen	Description
Status Screens	Date: 2013-07-13 Time: 13:00:00	Current date and time. Date is setup using the Date Screen in the Main Setup Menu. Time is setup using the Time Screen in the Main Setup Menu. Time is in 24-hour format.
	Status: NOT RDY 00000/00060 sec	The Status Screen can be viewed by pressing the ▼ key.
	Status: LOGGING 00000/00060 sec	Displays LOGGING when a Secure Digital™ card is inserted. Displays NOT RDY when no memory card is inserted or there is an error accessing the card. The first number shows the number of time (seconds) since the last write to the memory card. The second number shows the logging interval.
Main Setup	Main Setup Menu <- SELECT ->	Press the SELECT button to enter the Main Setup Menu. Use the screens in the Main Setup Menu to configure and calibrate the wind data logger. Use the ▼ and ▲ buttons to change user calibrated values and SELECT to set values.
	Logging Disabled while in setup!	Briefly displays to remind user that system is offline during setup.
Setup	Date: 2013-07-21 <- Set ->	The Date Setup Screen will display. Press the SELECT button to set the date.
	Date: 2013-07-21 - Set +	The last digit of the year is underlined. Press ▼ to decrease the year or ▲ to increase the year. When year is correct, press SELECT to set the year and move to the month. Set the month and day using the same method. Press SELECT to return to the Date Setup Screen.
	Time: 15:31:30 <- Set ->	Press ▲ to advance to the Time Setup Screen. Press SELECT to set the time.
	Time: 15:31:30 - Set +	Note that the last digit of the hour is underlined. Press the ▼ to decrease the hour or ▲ to increase the hour. When the hour is correct, press the SELECT button to set the hour and move to the minutes. Set the minutes and seconds using the same method. Press SELECT to return to the Time Setup Screen.

1 minute logging at the top of the minute :00 has been selected rather then free running

DATA LOGGING

The WS-25 data logger can record measurements directly to an industry standard Secure Digital™ or Multi-Media Card™. The data logger records both raw and processed values in a simple text format that can be opened with any spreadsheet or text editor.

STARTING AND STOPPING LOGGING

Logging commences after the memory card is inserted into the data logger and terminates after it is removed. Use the Logging Status screen to verify that the data logger is recording. If a memory card is inserted but the data logger shows "NOT READY" then there is a problem and the data logger WILL NOT record anything. Check to be sure the card is fully inserted and meets the memory card requirements outlined below.

MEMORY CARD REQUIREMENTS

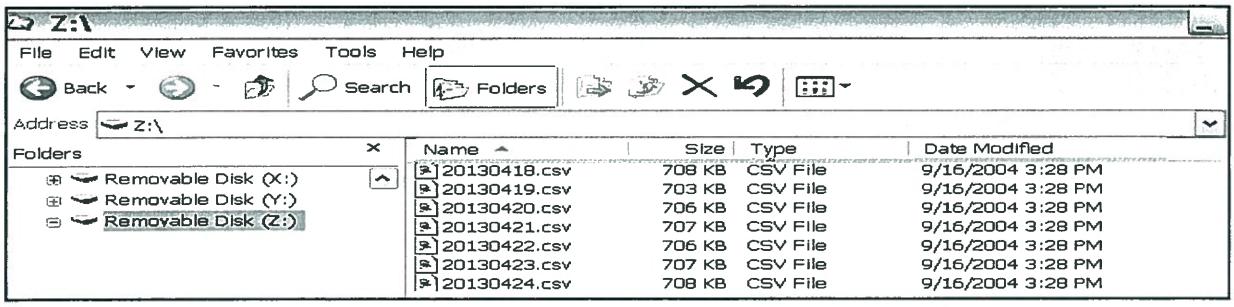
The WS-25 data logger is compatible with all sizes of SD (Secure Digital™) or MMC (Multi-Media Card™) cards; however, it will not work with Secure Digital High Capacity (SDHC) cards.
There is no need to format the SD card for this data logger mode

DATA

The WS-25 data logger generates one file per calendar day. The file name is YYYYMMDD.CSV (ex. 20130713.CSV) where YYYY is the four-digit year, MM is the two-digit month, and DD is the two-digit day. Each file is stored in the main directory or folder of the SD or MMC. The data logger also writes two other files that contain meta information about the channels being logged. For most applications these files can be ignored. The file consists of one record per line. On most computers, a single file can be opened in a text editor by simply double clicking on its icon.

The data logger records Comma Separated Vertical (CSV) files to the memory card. CSV data can be used by nearly any spreadsheet software, First launch the program, then use the 'Open' command in the File menu to select the CSV file created by the data logger.(The Date Modified column has no function and can be ignored)

Microsoft Excel, Gnumeric, and Open Office.org Calculator are all good spreadsheet programs. Gnumeric and OpenOffice.org Calc are free and can be downloaded from the Internet.



2013-06-23 00:02:30,1.9,3.0,19,,,,,,,,0.00,88,12.18,,,,71.829,28.556,965.721,,67
2013-06-23 00:02:31,2.3,2.3,16,,,,,,,,0.00,91,12.14,,,,71.829,28.556,965.455,,120

Sensors

The standard WS-25 sensors have been designed to be rugged, compact, and lightweight. They interface directly to the data acquisition module without the need for additional signal conditioning.

Wind Speed and Direction ~ 200-WS-02F

The wind sensor combines a three-cup anemometer and a wind vane on a single axis. The anemometer is a contact-type wind sensor which, when rotated by the wind, triggers a series of momentary switch closures that are directly related to wind speed.
The wind vane uses a potentiometer to sense direction changes. Depending on the position of the potentiometer wiper, an analog voltage is output that corresponds to the position of the vane. By orienting the vane to North (360 degrees) during installation, wind can be easily calculated from the output voltage. The resolution of the wind vane is 1 degree (azimuth display), or 16 compass points (on Lcd display only).

Barometric Pressure 100-WS-25BP..... *(Optional on portable stations)*

The barometric pressure sensor is set for sea level when it leaves the factory.
It will read absolute pressure. Barometric pressure varies with elevation, the Data logger can be set up to read corrected to sea level pressure for the elevation at which it is installed. This is done adding the correct offset in inches in the analog setup menu , you will need to know the correction in inches for the Elevation at your location before you change it.
Instructions are provided in the manual.

Temperature and Relative Humidity 110-WS-25TH

The WS-25TH is a combination temperature and relative humidity is installed a radiation Shield .Temperature and Humidity are sensed using a sensor element which changes voltage with temperature and Humidity fluctuations.
(The warm-up time to stabilize is 10 minutes)

Rain 110-WS-25RG *(Optional on portable stations)*

The 8 inch rain gauge with Mast mounting arm provided with the WS-25 is a traditional tipping bucket design. Resolution is 0.01 inches (0.254 mm) per tip.

2.0 INSTALLATION

Installation of the WS-25 is simple and straightforward, thanks to its modular design and terminal-strip connections.

2.1.2 Tripod Towers

The five-foot tripod tower provided with the WS-25 is constructed of steel tubing for durability and strength. Horizontal bracing is a feature of the tripod tower. The tripod's foot brackets can be bolted onto a concrete foundation or a wooden platform. The wind speed and direction sensor mounts on top (the tapered end) of the five-foot aluminum sensor mast. The solar radiation shield (for the temperature and humidity sensor) and the rain gauge mounting arm are supplied with u-bolts to clamp onto this mast. For stability, we recommend that the mast be inserted into both of the tripod's collar clamps. Guy kits are recommended for areas of high winds and ground kits are recommended for areas with lightning activity.
The WS-25P Portable Stations include a 3 foot tripod, with two 3 foot mast that connect together end to end.

Caution: When installing the wind sensor, make sure that the sensor and cable are well clear of any power lines.

2.1.3 Lightning Protection and Grounding

A Copper lightning protection ground lug, located on the data acquisition Nema module, this is the path to ground for all of the lightning protection circuitry in the WS-25N.
Connect a heavy Copper wire to this Lug the other end connects to a grounded outlet or water pipe or Earth ground. In areas subject to severe lightning activity, we recommend that you install a grounding rod.

2.2 Power Connections

The WS-25 runs on 12Vdc Power ,It can be operated from a standard AC/DC power adapter connected to a110~ 240 Vac outlet, or from a 12Vdc battery. on nema, and portable versions

2.2.3 Main Memory Battery Backup

The WS-25 main memory has a lithium battery backup so setup parameters, as well the date and time stored data, will be retained even if the primary power source is interrupted.

2.3 RS232 Interface Is Available , but not needed,
It is used when the User is connecting the Optional Real Time Graphical Display Software

The WS-25 outputs serial data communication between the user and the WS-25 is accomplished using RS232 communications protocol designed for short-distance use.

The standard 6-foot serial interface cable that connects the data acquisition module to the computer is terminated with a 9-pin "D" connector. The serial cable can be extended up to 200 feet.

For computers without a serial port, a USB-to-Serial converter may be used. When installing the converter, be sure to note the Com port number it is assigned.

Certain communications parameters must be specified in the computer to enable the two devices to communicate. Using a communications software program such as HyperTerminal , TeraTerm or Putty, set them as follows:

Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None
Emulation	ANSI

2.3.1 Testing the Connection

Once the WS-25 is connected to the computer, the connection can be tested by turning the power on to the WS-25
If the RS232 connection is sound, a line of Data will show every minute

2013-09-23 16:02:30,1.9,3.0,19,,,,,,,,0.00,88,12.18,,,,71.829,38.556,29.721,,67

A RS232 Output Tester lite is supplied with the unit.
If the Serial output is functioning, the red light should flash every minute.

If the WS-25 is functioning but you see nothing on the PC screen, then the wrong serial port may be selected. Try selecting Com 3 or another functioning serial port. You can see a list of available ports in My Computer > System Properties > Device Manager > Ports.

2.4 Sensor Installation

Install the sensors in their chosen locations, bearing in mind the installation considerations noted earlier. Run cables from the sensors to the data acquisition module location, with no cable exceeding the maximum allowable length listed below.

Sensor	Maximum Cable Length
Wind*	200' (66m)
T/RH*	150' (82m)
Rain*	200' (66m)
Barometric Pressure**	10' (3m)
Solar Radiation*	100' (33m)
*Std cable length 40' **Std cable length 18"	

When the sensors have been installed and the cables run, connect and test them as described in the following sections. Refer to the hook-up drawing at the back of this manual to verify wire colors and physical connections.

2.4.1 Data Logger Module

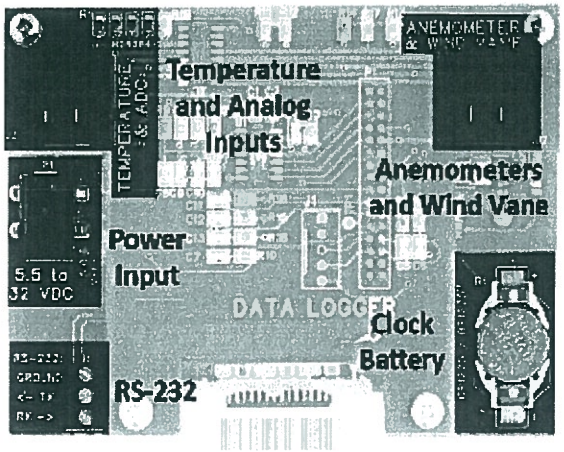
The data Logger module is configured at the factory for the following sensors:
normally in English US units. For Foreign locations the Station is set up in metric units
The units can be changed to English or metric if necessary in the Sensor Set up menus

1. Wind speed and direction
2. Barometric pressure *(Optional on WS-25P portable station)*
3. Temperature and Relative Humidity
4. Rain Gauge *(Optional on WS-25P portable station)*

CLOCK BATTERY BACKUP

The data logger's real-time clock uses a 3-volt lithium coin cell battery to maintain the clock while power is disconnected. CR1225, BR1225, or any 3-volt 12.5 by 2.5 mm battery may be used. These are common watch batteries and should be available from most stores.

The clock battery has an estimated 10 to 15 year life span in the Wind Data Logger. If your data logger "freezes" or does not retain its date and time without power, then the battery likely needs to be replaced. To replace the battery, use a small screwdriver or toothpick to pop the old battery out of the battery holder. Insert a new battery with the writing side up.



Data Logger circuit board.

Advanced information If Needed :::

These are the DEFAULT SETTINGS NOVALYNX WS-25 for Programming Each channel Using Standard WS-25 Sensors with English Units.

Anemometer 0
m = +0001.2500 WS-02F (for m/s m = +0.567 for knots m = +1.10, for kmh m= +2.59)
b= +0000.0000
I= WIND SPEED
u= MPH (u = M/S , u =KTS , u=kmh)

Anemometer 1
m = +0001.2500
b= +0000.0000
I= WIND SPEED
u= MPH

Anemometer 2
m = +0001.2500
b= +0000.0000
I= WIND SPEED
u= MPH

WIND VANE SET UP
Linear *
Dir Offset 000°

Log Interval
Log Sec 00060

Counter Setup
Counter 0 OK AS is
Counter 1 OK AS is

Counter 2
m= +0000.0100 WS-25RG (for millimeters m= +0000.2500
b= +0000.0000
I= RAIN TODAY
u= IN. (u=mm)

ANALOG SET UP
Analog 0 Ok As -is
m = +0008.000
b = +000.0000
I = INPUT VOLTAGE
u = VDC

Analog 1 OK AS-is
m = + 0001.000
b = + 0000.0000
I = WIND DIR.

u = VDC

Analog 2
m = +0598.8020
b = +0000.0000
l = SOLAR RAD.
u = W/M

Analog 3 Aux. temp only
m = +0180.000 For degrees C m = +0100.0000
b = -0459.6900 For degrees C b = -0273.1500
l = AUX. TEMP
u = °F For degrees C u = °C

Analog 4
m = +0070.9092 For degrees C m = + 0039.394
b = -0022.0000 For degrees C b = - 0030.0000
l = TEMPERATURE
u = °F For degrees C u = °C

Analog 5
m = +0030.3030
b = +0000.0000
l = HUMIDITY
u = %

Analog 6 * The b value will be different on each sensor
m = +0006.4375 for millibars m= +0218.0000
b = +0003.6600 * for millibars* b= +0124.5400
l = BARO.PRESSURE
u =IN. for millibars u= mb or hpa

Analog 7
m = +0001.0000
b = +0000.0000
l = EXT. ADC
u = VDC

Channels to Log (These 7 are Enabled, the others are Disabled)
Anemometer 0
Counter 2
Wind Direction
Analog 0
Analog 4
Analog 5
Analog 6

RS-232 Enabled
Baud : 9600

SITE NAME
WS25

Data Record Format Information on Memory Card

There are no description headers generated on the stored Data 23 Fields are generated , but only the ones being used are saved, the,,, is where the missing fields would appear if the were needed

Sample Data with the **6 Standard Sensors connected WS-25DL** 1 min logging, English units

Date and Time, Speed , Gust , Spd count,,,,, Rain , W.Dir., inVolts , Temp ° F, Hum %, BP inhg, cksum

2013-09-15 02:19:00, 0.3, 0.9, 19,,,,,,,,, 0.00, 351, 12.14,,,, 83.1, 26.7, 28.473,, 230

2013-09-15 02:20:00,0.7,1.2,28,,,,,,,,,0.00,351,12.14,,,,83.1,26.7,28.465,,95

2013-09-15 02:21:00,0.9,1.4,31,,,,,,,,,0.00,351,12.14,,,,83.1,26.7,28.465,,8

Sample Data with the **4 Standard Sensors connected WS-25P** ,1 min logging, English units

Date and Time, Speed , Gust Spd count ,,,,, Direction Input Voltage , Temp ° F Humidity % ck sum

2013-09-18 17:58:00, 4.9, 22.2, 277,,,,,,,,,, 249, 13.08,,,, 73.301, 18.088,,, 198

2013-09-18 17:59:00,2.7,12.6,128,,,,,,,,,,269,13.04,,,,73.387,18.310,,,36

2013-09-18 18:00:00,3.2,3.5,83,,,,,,,,,,315,13.08,,,,73.474,18.458,,,44

Many WS-25DL are set up in Metric Units with m/s , ˚C , millimeters and millibars
Refer to the Quick Start As Shipped Sheet for Your Exact Set-up

CONVERTING Wind Speed PULSE COUNT TO AVERAGE WIND SPEED

The 'Wind Pulses' screen in the Main Display Loop shows the number of anemometer revolutions since the last write to the memory card. The pulse count information can easily be converted to average wind speed using the following formula, Average Wind Speed = ((WCx/sample_interval) * anemo_m) + (anemo_b)

Example using the following snippet of data from the data logger WS-02 sensor and a sampling interval of 60 seconds recording in MPH:
2013-07-14 16:11:00,18.0,19.4,810
As seen in the data snippet above or the reading from the data logger 'Wind Pulse' screen, WC0 = 810. This information can then be used with the formula above:
Average MPH = ((810/60) * 1.25) + 0.0 = 16.87 MPH

A Complete WS-25 Logger manual with internal PCB Schematics is Available upon request.

NOVALYNX CORPORATION

MODEL 110-WS-25RG

TIPPING BUCKET RAIN GAUGE

and

Model 260- 0111

INSTRUCTION MANUAL

REVISION DATE: Aug 2013

Receiving and Unpacking

Carefully unpack all components and compare to the packing list. Notify NovaLynx Corporation immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. Damages to equipment sent via Parcel Post or UPS require the consignee to contact NovaLynx Corporation for instructions.

Returns

If equipment is to be returned to the factory for any reason, call NovaLynx between 8:00 a.m. and 4:00 p.m. Pacific Time to request a Return Authorization Number (RA#). Include with the returned equipment a description of the problem and the name, address, and daytime phone number of the sender. Carefully pack the equipment to prevent damage or additional damage during the return shipment. Call NovaLynx for packing instructions in the case of delicate or sensitive items. If packing facilities are not available take the equipment to the nearest Post Office, UPS, or other freight service and obtain assistance with the packaging. Please write the RA# on the outside of the box.

Warranty

NovaLynx Corporation warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. NovaLynx Corporation's obligations under this warranty are limited to, at NovaLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall NovaLynx Corporation's liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by NovaLynx Corporation, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

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4055 Grass Valley Highway, Suite 102
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Email: nova@novalynx.com
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NovaLynx Corporation

1.0 INTRODUCTION

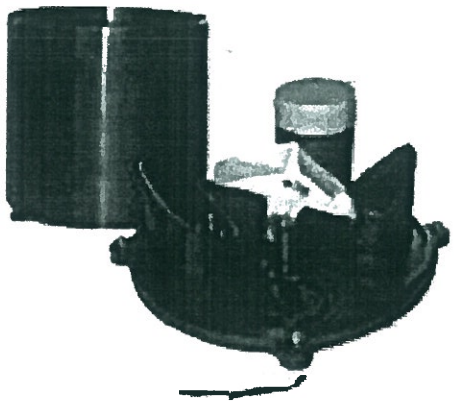
The Model 260-0111 Rain Gauge with 8" diameter collector
meets NWS specifications for statistical accuracy.
Every time the bucket tips, a count is transmitted to the recording device and the gauge empties. You never have to empty the gauge.
Each tip of the bucket is equal to one hundredth of an inch
The body and base of the collector are constructed of tough, UV resistant plastic. The tipping bucket pivots on stainless steel shaft to minimize friction and wear. Adjustment screws under each chamber of the tipping bucket allow you to fine-tune the calibration.
For General Testing connect the Rain Gauge output to a Counter, or Ohmmeter to verify that each tip will cause a momentary switch closure .
A Debris Screen is in rain gauge cone to help prevent debris from clogging the funnel hole. .

- Optional Mounting Arm - The mounting arm provides easy mounting of the gauge to the tripod mast using a 1-3/4" u-bolt., comes standard with the 110-WS-25RG

Four Mounting holes are pre-drilled in the base and four Screw are provided for installation on to a flat surface .

specifications

Resolution: 0.01"/tip
8" diameter (20.5cm) collector meets NWS
Switch: Dry reed switch
Output: < 0.1 sec switch closure
Accuracy: ± 2% at < 2" per hour
Cable : 60 feet of 2 conductor



3.0 INSTALLATION

3.1 Choose a Location

The location of the rain gauge is very important to the successful operation of the instrument. The most accurate measurements are made in relatively sheltered areas protected from gusting and turbulent winds. Openings in orchards or a grove of trees offer the best exposure for the rain gauge. Fences and other structures can help serve as a wind break as long as they are not too tall.
Generally, the heights of objects near a rain gauge should be proportional to the distance away from the gauge. The distance of a nearby object should be at least twice the height of the object above the gauge.
Keep the following in mind when choosing a location for your rain gauge.
The rain gauge must be level. Verify using the bubble level across the funnel opening.
Choose a location which is easily accessible for normal cleaning and is distant from trees or other sources of heavy pollen or debris.

Installation and Operation of the Rain Gauge

1. The following items should be included in the shipping box:
The Rain Gauge with 60 ft Connecting Cable (this cable can not be buried)

2. Determine a location for the Rain Gauge keeping in mind the following guidelines:
a. Choose a flat, level surface.
b. Make sure the area is open with no overhanging obstructions.

3. Back out the four (4) screws holding the collector onto the base until it can be rotated to a point where the collector can be removed from the base.

4. Remove the collector. Using the four (4) screws supplied with the gauge, mount the base at the location you determined in Step 2. Do not replace the collector.

5. Run the wire from the gauge to location of the Data logger, or recording device.
The cable is rated for outdoor use but it cannot be buried.

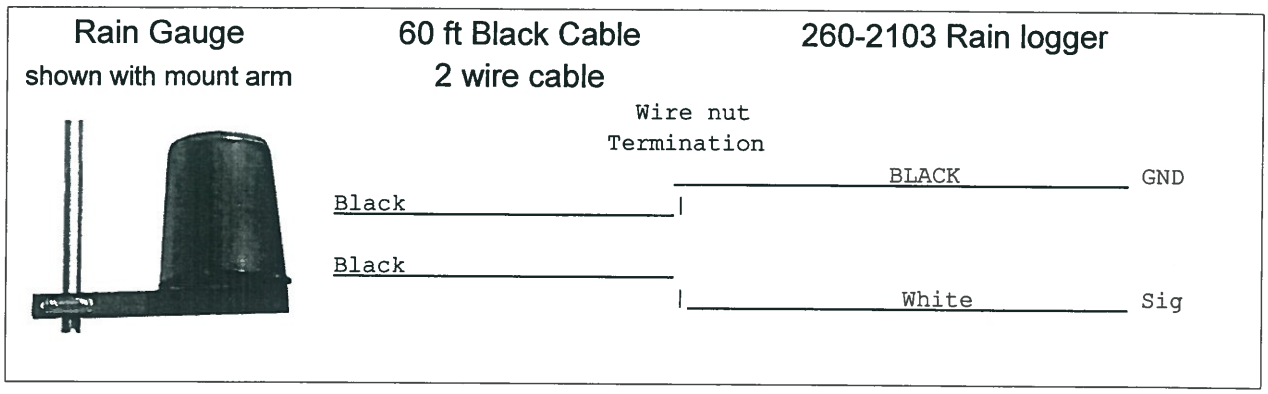
6. Move the dipper in the bottom of the Rain Gauge base back and forth. You should see a count on the Logger display for every tip of the bucket.

7. Place the Rain Gauge collector back onto the base, rotating the collector until the ears are fully under the screw heads. Tighten the screws until they are snug (Do not over tighten).

This completes the installation. Now you must wait for the rain.

Typical Wiring Connection

Attach the two leads of the rain gauge black cable to the appropriate connectors on the data logger . The wires are both black and can connect to either terminal , polarity is not important for this connection



5.0 MAINTENANCE

For greatest accuracy, you should thoroughly clean the rain gauge at least once or twice a year.

1. Disconnect the rain gauge cable from the data acquisition module.

2. Separate the cone from the base.

3. Use warm soapy water and a soft cloth to clean pollen, dirt, and other debris from the cone, cone screen, and bracket.

4. Use a pipe cleaner to clear the funnel hole in the cone and the drain screens in the base.

5. When all parts are clean, rinse with clear water.

6. Reattach the cone and replace the screen.

7. Reconnect the rain gauge cable to the data acquisition module.

6.0 TROUBLESHOOTING

Before calling technical support, carefully check the following troubleshooting guide. You may be able to solve the problem yourself.

6.1 Rainfall is not registering on the display or has a large error

- Check the cable connections from the sensor to the module. Cable connections account for a large portion of the potential problems. Connections should be firmly seated in the terminal strip and plugged in straight. If you think a connection may be faulty, try jiggling the cable while looking at the display. If a reading appears intermittently on the display as you jiggle the cable, the connection is faulty.

- Make sure there is no magnetic, steel, or iron object near the rain gauge.

- Make sure the funnel hole in the cone is clear so water can empty into the bucket.

- Make sure the bucket moves freely when tipping to both sides. The or logger display should show an increase in rainfall for each tip of the bucket.

- Check signal with an ohmmeter. A momentary switch closure should be observed each time the bucket tips.

6.2 Rainfall amount shown on the display has a small error

- Make sure the rain gauge is mounted on a level surface. Use the adjustment screws to adjust the rain gauge's sensitivity, if necessary.

NOVALYNX CORPORATION

MODEL 320-600
ST-10 SOLAR PANEL

INSTRUCTION MANUAL

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SOLAR PANEL
MODEL 320-600-A

1.0 INTRODUCTION

Meteorological instruments and systems are often located in remote areas to gather localized weather data. Many times, these remote areas do not have commercial grade power or the local power lines are not accessible for use at the instrument site. To overcome this lack of power, a majority of meteorological instruments and systems have been designed to operate from +12 volt batteries. Since batteries have a limited capacity there should be some method of replacing the batteries on a regular basis or there should be the ability to recharge the batteries at the remote site.

NovaLynx Corporation, provides a solar battery charger, Model 320-600-A, for recharging batteries used at remote meteorological sites. The solar charger uses the sun's energy to produce an electric current. It is this "solar current" that is used to recharge the system batteries. At sites where there is an abundance of sunlight, the solar charger will keep the batteries at high level of charge. A charging regulator used with the solar panel prevents the batteries from being over-charged and from being charged at current levels that may damage the batteries. The regulator also prevents the battery power from being discharged back through the solar panel at night. A small red indicating lamp on the regulator is used to indicate that charging is occurring.

The Model 320-600-A is composed of the photovoltaic panel, the regulator, a mounting bracket, mounting hardware, and a twenty foot length of cable. Standard mounting hardware that fits a 1" pipe or a mast with an outside diameter of 1 1/2" has been provided. The photovoltaic panel mounting bracket allows adjustment of the panel angle to obtain maximum performance.

2.0 SPECIFICATIONS

MODEL 320-600-A

Output:	0.6 Amps (10 Watts), maximum (at 1000 W/m^2 and 25°C)
Regulated Voltage Output:	14.3 VDC
Panel Size:	14 3/16" Wide x 13" High x 1 3/8" Deep
Regulator Size:	4 5/8" Wide x 2" High x 1 3/8" High
Standard Cable Length:	20 feet
Cable Type:	1 pair, 20 AWG, Stranded, PVC Jacket
Standard Mounting:	2 each U-bolts, 1 1/2" O.D. mast

3.0 INSTALLATION

The Model 320-600-A solar charger panel has been designed to be mounted onto a vertical pipe (tower leg) or mast using two u-bolts to fasten the panel to the pipe. The pipe or mast should be as close to true vertical as possible. A "U" shaped mounting bracket is provided with the photovoltaic panel. It is the "U" bracket that is actually bolted onto the mast. Four screws are then used to attach the bracket arms onto the photovoltaic panel. The bracket has been designed so that the arms are attached to the outside edges of the panel. One of the screw holes on each arm has been slotted at an arc allowing the panel angle to be adjusted.

Installation of the photovoltaic panel in any manner other than the one described here may interfere with the proper operation of the panel or may damage the panel. Please contact NovaLynx for assistance with special installation requirements.

CAUTIONS: The photovoltaic panel will produce electricity as soon as the front surface is exposed to either direct or indirect sunlight. Cover the face of the panel with an opaque material to prevent production of electricity during the panel's installation. Make sure that the wires from the regulator to the battery have been disconnected or have been covered with electrical tape or wire nuts to prevent the wires from shorting together. Avoid touching the terminals of the regulator during the panel installation. DO NOT reverse the battery wires "Positive" and "Negative" at the regulator terminals. Reversed polarity of the battery wires will damage the regulator circuit. NEVER connect the solar panel directly to the battery and then to the regulator. Damage to the regulator will occur. Always connect the Solar Panel directly to the regulator.

The location of the panel should be selected so that there will be no shading of the panel surface between the hours of 9:00 AM and 3:00 PM (solar time) on the shortest day of the year. Even a partial shading of the panel is to be avoided. Areas that have lots of trees, especially deciduous trees, may require repositioning of the panel during spring and summer months. Try to avoid tree shading whenever possible. In some cases, it may be best to install the solar panel onto a post or pipe that is adjacent to the meteorological system but not directly onto the system tower. Select a height for the panel that will keep it above drifting snow and localized flooding. The higher the panel sits the less likely it will be tampered with. For best results, the panel should only be accessible by using a ladder.

Make sure that the surface of the panel is facing South. It is common for solar panels to be incorrectly installed by aiming the panel at the sun during the installation. Remember that the sun travels across the sky during the day and it is not always at South on the horizon. Use a compass to locate magnetic North and select an object that is directly South of the site as a marker to help align the panel to South. Secure the u-bolts as soon as the panel is correctly oriented.

In addition to facing South, the solar angle of the panel should be set for maximum solar exposure during winter months. This angle will vary with latitude. A label showing the tilt angle is attached to one of the "U" bracket arms to assist in setting the panel's solar angle. Solar or tilt angles are defined as the angle between the back plane or back surface of the panel and the earth's horizon. The smaller the tilt angle, the more the panel's surface will face skyward. The larger the tilt angle, the more the panel's surface will face the horizon.

Refer to the table below for suggested tilt angles. Note that the angle changes with latitude. If the local latitude is not known, contact the nearest airport or National Weather Service office.

LATITUDE IN DEGREES	TILT ANGLE IN DEGREES
0 to 15	15
15 to 25	Angle Equals Latitude
25 to 30	Latitude + 5
30 to 35	Latitude + 10
35 to 40	Latitude + 15
>40	Latitude + 20

All of the mounting screws should remain loose until the panel has been fully installed and aligned to South. The two lower panel mounting screws have the slotted holes for adjusting the panel angle. After the angle has been set, the four screws can be tightened. Use caution to avoid scratching the back of the solar panel.

After the panel has been installed and it is operating correctly, clean the panel surface to remove finger prints, dust and dirt. Use clean water and a soft cloth to clean the panel.

Prior to connecting the wires from the solar panel to the regulator and the battery, attach a ground wire to the solar panel frame. Use a number 10 sheet metal screw and a flat washer to secure the ground wire to the frame. Use the existing hole located on the back surface and in the middle of the bent aluminum frame. Whenever a ground wire greater than 10 AWG is to be used, it may become necessary to add a suitable ground wire connector to accommodate the larger wire size. The other end of the ground wire must be connected directly to a ground rod or a good Earth ground system.

For most NovaLynx supplied systems, the normal Solar Panel installation wiring requires only the connection of the twenty foot cable to the system battery. Connectors for both the Solar Panel and the battery ends of the cable are provided and attached to the cable by NovaLynx. At the Solar Panel end of the cable there are two spade lugs that are used to connect the cable to the regulator. A molded, two-pin quick disconnect is used at the battery end of the cable. NovaLynx provides a short length of cable with the mating half of the quick disconnect and two terminal lugs for the battery connections. Observe the polarity of the battery terminal connectors: Red is positive (+) and Black is negative (-). This method of cabling allows quick and easy transfer of the Solar Panel from one battery to another whenever battery replacement is needed.

For more detailed assembly information, please use the following instructions.

1> Route the Red and Black wires from the Solar Panel junction box to the regulator terminals. Attach the wires to the terminals as shown in the regulator outline drawing, number 10000305. The solar panel wire terminals are labelled "ARRAY +" and "ARRAY -" with the positive terminal on the left side as shown in the drawing.

2> Install the cable from the battery to the solar panel before attaching the battery wires at the regulator terminals. Check to make certain that there are no breaks or exposed wires along the cable.

3> Securely fasten the cable to its support structure to protect it from damage due to high velocity winds. For tower mounted systems, use plastic or stainless steel wire ties to secure the cable. Plastic wire ties should be UV resistant. Apply wire ties at two foot intervals. For other types of structures, use the most appropriate cable fastener available. Consult local electrical contractors for assistance, if necessary. Leave a loop of cable at each end of the run to allow movement of the battery and the solar panel during maintenance. Fasten the loop to the structure after everything has been put into place.

4> Attach the cable wires to the regulator. The regulator terminals are labelled BATT with the Positive terminal on the left and the Negative terminal on the right. Notice that the BATT terminals are on the outside of the two ARRAY terminals. Use spade lugs to connect the wires into the regulator terminal screws. NovaLynx will provide the appropriate connectors already attached to the wires whenever possible.

5> Attach the other end of the twenty foot cable to the battery terminals. Use quick disconnect terminal lugs. Observe the battery terminals' polarity. Check to ensure that the terminal lugs are fastened securely. A tight fit is best. Loose battery terminals can prevent proper charging of the battery.

In most cases, Solar Panels ordered and delivered directly from NovaLynx will have the wires attached at the factory. Refer to the regulator drawing to verify the terminal positions for the battery wires. There is no special sequence regarding whether the battery or the regulator is wired first. If the regulator is wired first, make sure that the battery end of the wires are covered to prevent an electrical short. Uncover the wires as they are attached to the battery.

4.0 THEORY OF OPERATION

Battery powered equipment is restricted to a period of operation dictated by the battery's storage capacity and the current drain of the equipment being powered by the battery. Most battery powered equipment is equipped with a device that will cycle the equipment ON and OFF to conserve and to extend the battery's power. Eventually, the battery must be replaced with either a new or a recharged battery. For equipment such as meteorological instruments and systems, it is not always convenient to travel to the equipment site to exchange batteries. If a major weather event is occurring at the time of the battery exchange it may be impossible to gain access to the equipment site. The solution to these types of battery problems lies in the use of photovoltaic battery chargers such as the NovaLynx Model 320-600-A. The photovoltaic panel along with a charging regulator can keep most battery powered systems operating continuously and many times, indefinitely.

The photovoltaic panel used in the 320-600-A is a high efficiency electrical generator with single crystal silicon cells. It is the physical characteristics of the silicon crystals that create electrical current from sunlight. By arranging the cells into an array and connecting them in a specific manner, a known electrical current at a known voltage can be produced. For the 320-600-A the maximum current produced is 0.6 amperes at +14.3 volts DC.

The silicon cells are laminated to tempered glass with EVA. The silicon cells have an anti-reflective coating for improved efficiency. This laminated package is supported by a metal frame. The solar panel has been designed for ease of use and is equipped with permanently attached wires.

The regulator has been designed to operate automatically for long periods. When in the charge mode the regulator allows the maximum available current from the solar panel to flow into the battery through a blocking diode. The Charging light is ON during current flow. As the battery charges, the voltage will increase slowly until it reaches about 14.3 volts. At this point, the light turns OFF and battery charging stops. When charging stops the battery voltage will begin to fall. When the voltage reaches about 13.5 volts the charging will resume.

A typical daily charging cycle starts with the battery at some level below its fully charged capacity. As the sun rises, charging begins and will be continuous. Current passes into the battery for some time. Eventually, current flow stops. Later on, depending upon the systems's power demands on the battery, charging will resume. This cycle may repeat many times throughout the day. During the course of the day, the duration of each charging cycle will decrease as long as only a small amount of battery power is used by the system. As the battery approaches a full charge, the regulator will pulse current into the battery to achieve and to maintain a full charge. Pulse charging is indicated by an occasional ON and OFF cycle of the charging lamp.

Typically, the NovaLynx Model 320-600-A Solar Panel, when used with a 7 Amp Hour Gel Cell battery, will provide continuous operation for a 60 to 80 mA constant load.

5.0 MAINTENANCE

Maintenance of the solar panel is minimal but must be performed regularly to ensure maximum performance of the equipment.

Whenever possible, clean the solar panel surface. Use only clean water and a soft clean cloth. For heavily soiled panels, use a mild liquid detergent to help remove the dirt and grime. NEVER use any abrasive detergent or sponge on the panel's surface. Scratches will affect the panel's output.

At least twice a year, check all of the mounting hardware to ensure that it is tight and in place. Replace any damaged or missing hardware immediately. Replace the panel immediately if there are any cracks in the glass surface. Check the solar panel's angle and correct it if it is wrong. Check all wiring connections. Wiring terminals and terminal screws should be tight and free of corrosion. Areas with excessive corrosion may be easier to maintain by covering the terminals with rubber electrical compound. The regulator may be moved to a distance of up to ten feet away from the panel. Use at least an 18 AWG wire to connect the regulator to the solar panel in these instances.

Damaged or improperly operating solar panels may be covered under the manufacturer's warranty. Please contact NovaLynx for any assistance with defective solar panels.

6.0 TROUBLESHOOTING

Should problems occur immediately after the solar panel has been installed perform a quick check of the following items:

> Check all power wiring from the solar panel to the battery. Make sure that the polarity of the connections is correct.

> Check all equipment fuses and circuit breakers. Before replacing a blown fuse locate and correct the cause of the problem.

> Check all wiring connections. Crimped terminals can loosen and become a source of problems. A good fix is to solder the wire at the crimped terminal.

> Check for a voltage drop between the solar panel regulator and the battery. Voltage drops can occur when there is an old fuse or a loose connection.

> Check for an output at the regulator. The charge lamp should be ON continuously during exposure of the panel to sunlight. Disconnect the battery wires at the regulator and measure the terminals with a voltmeter. High voltage from nearby lightning may cause damage to the regulator despite its internal lightning protection.

> Check the unloaded output of the solar panel. Disconnect the regulator from the panel. Measure the panel wires with a voltmeter. Measure both voltage and current. The solar panel must be in full sunlight and its surface must be clean.

Some common problems and their solutions are presented in the following text. These may not be all of the problems that can occur to the solar panel and the charging regulator. Please contact NovaLynx for assistance if a particular problem is not listed below.

1. There is a continuous low voltage condition at the battery. With the charge light indicating good charging during daylight hours, the regulator would appear to be operating correctly. The problem could be due to an incorrectly sized solar panel for the system battery and the local climate or the battery is defective.

2. A low voltage condition with no charge lamp ON would indicate a lack of output from the solar panel, a bad connection, or a defective regulator.

3. A moderate voltage condition where the charging appears to stop too soon (below 14.1 volts) would indicate a bad battery connection or a defective regulator. A bad battery connection could cause the regulator to sense a higher battery voltage than the one that actually exists resulting in a premature shut down of the regulator output. Monitor the voltage at the BATT + and BATT - terminals of the regulator

until the charge light goes OFF. If the voltage at the regulator terminals is about 14.1 VDC then assume that there is a bad battery connection somewhere else.

4. A high voltage condition with additional charging would indicate that the battery voltage may be slightly under the charge termination set point and that charging should continue. This condition may also indicate a defective regulator if the battery voltage is high.

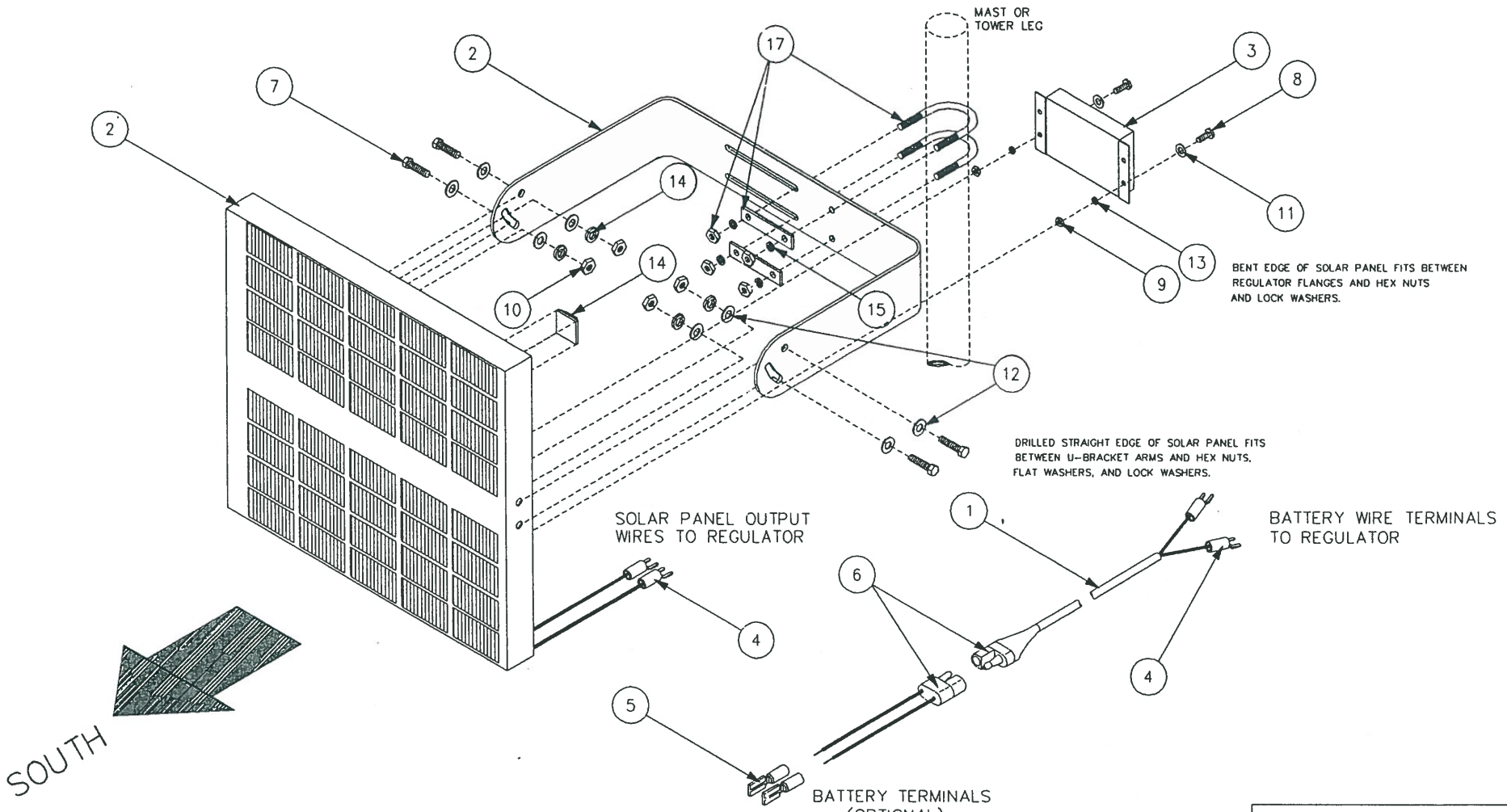
5. The charging light can be seen dimly at night if the panels are under low levels of light such as moonlight or street lights. A bright charging light at night would indicate that either the regulator is wired wrong or that the regulator is defective. To test the regulator remove the ARRAY + wire. If the light goes off, then it may be possible that there is enough low level light for a slight charge.

6. A rapidly fluctuating charging lamp can mean that there is a high charge rate with a fully charged battery and a load on the battery. The condition can also mean that the battery is defective and unable to maintain a charge or that there is a bad battery connection. To test this condition measure the voltage at the battery. If the voltage stays steady while the charging light goes ON and OFF, then there is probably a bad battery connection. If the voltage fluctuates with the light the battery is either bad or under sized. This condition may also be a result of a fully charged battery and the solar panel is providing a lot of charging current. The regulator can switch ON and OFF rapidly particularly when there is current used by the load. This last situation is normal and is not a problem.

7. A buzzing sound is produced by the regulator. The buzz is a result of the regulator switching ON and OFF rapidly and is due to a bad battery connection.

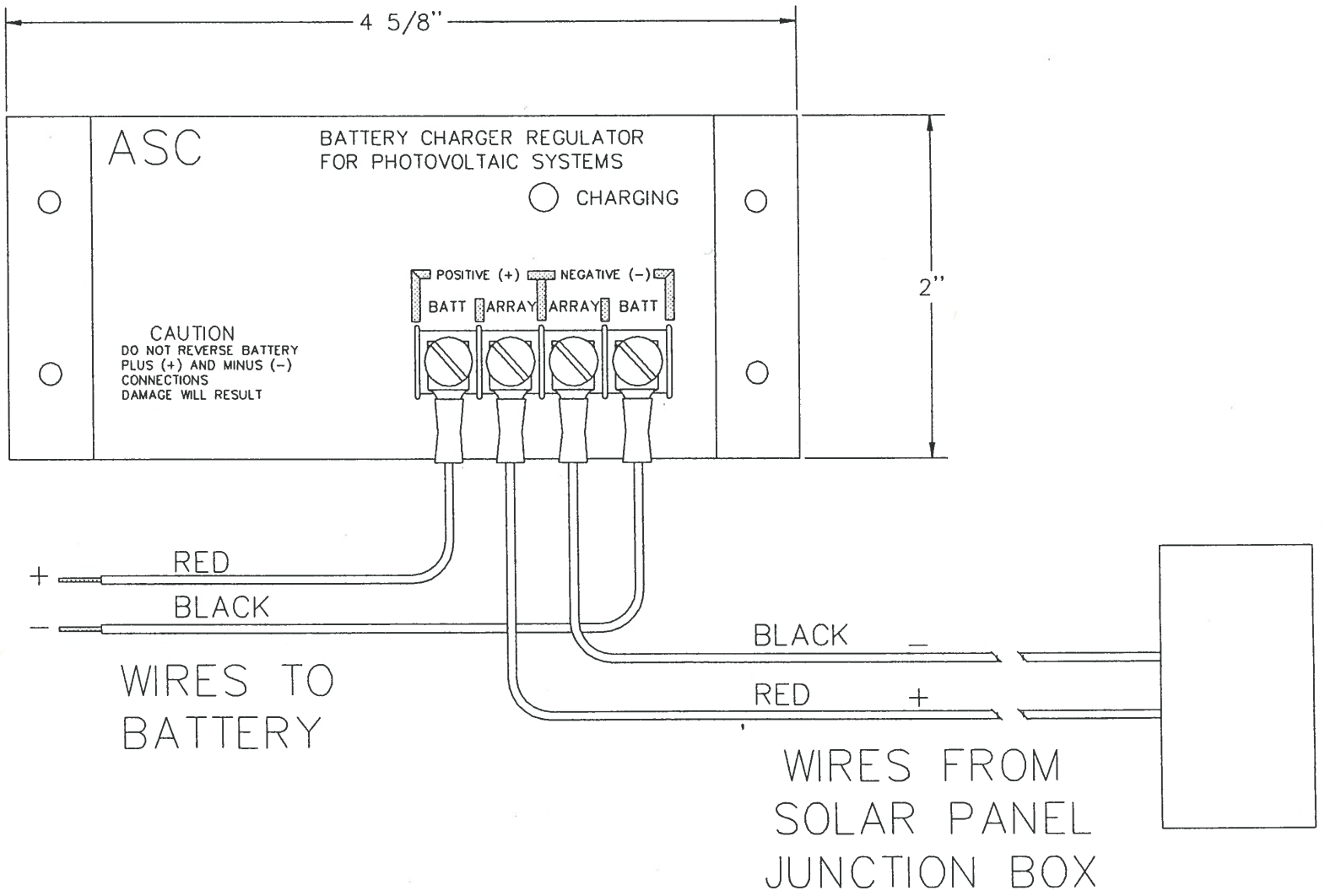
8. The regulator gets warm during normal operation. If the regulator is too hot to touch it may be defective.

9. A low voltage condition where the loads do not turn off indicates a very low battery. The load disconnect circuit stops functioning at about 8 volts.



NOTES: 1. NUMBER IN BUBBLE IS BOM ITEM NUMBER.
2. INSTALL PANEL WITH CELLS FACING SOUTH.
3. USE COMPASS TO LOCATE SOUTH.
4. QUICK DISCONNECT TERMINALS FOR BATTERY PROVIDED.

LUNAR ENERGY CORPORATION		D
TITLE: ASSEMBLY, SOLAR PANEL WITH REGULATOR		
MODEL USAGE - 320-600		SHEET 1 OF 1
BY RN	SCALE 1:1	DWG. NO. 10000304
DATE 9-15-97		



NOTE: 1. REGULATOR IS FOR +12 VDC POWERED SYSTEMS.
2. REGULATOR IS BOLTED ONTO SOLAR PANEL FRAME.

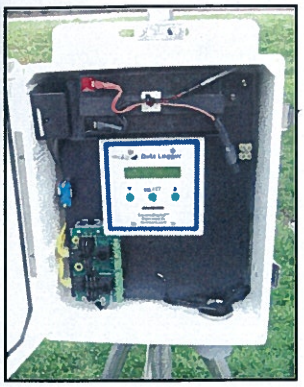
NOVA LYNX CORPORATION	C
TITLE: OUTLINE, CHARGER REGULATOR FOR SOLAR PANELS	
MODEL USAGE 320-600	SHEET 1 OF 1
BY RGN	SCALE 2:1
DATE 9-16-97	ACAD DWG. NO. 10000305

NOVALYNX CORPORATION

320-600-A / SOLAR PANEL 0.6 A (10V)

Part Number	Description	Quantity	
10000370A	SOLAR PANEL MTNG BRKT FOR MODEL ST-10	1	
2904-03	ADHESIVE TIE MOUNT 1-1/8"	1	
330-0220	CABLE 2C 20AWG UNSHIELDED	20	
40000901	SOLAR PANEL SIEMENS ST10	1	
40000907	REGULATOR ASC-12/1	1	
40803502	CABLE CLAMP 3/16DX1/2WX.20	1	
40818703	U-BOLT MAST CLAMP ASSY	2	
41900610	FLANGED SPADE TERM RED #6	2	
41900611	FLANGED SPADE TERM BLUE #6	2	
41900675	2-PIN QUICK DISCONNECT	1	
72040501	SCREW 1/4-20X1 HEX CAP SS	4	
72082004	SCREW 6-32X1/2 PAN SL SS	3	
72211401	NUT 6-32 SS (COARSE)	3	
72246101	NUT 1/4-20 SS	4	
72302106	WASHER #6 FLAT SS	3	
72302125	WASHER 1/4" FLAT SS	8	
72342106	WASHER #6 LOCK SS	3	
72342125	WASHER 1/4" LOCK SS	4	

QUICK START for the
110-WS-25N Nema Weather Station

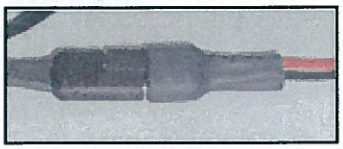


1. Set up the Tripod and Mount the Sensor, Wind, Rain, RH / Temp, (BP is connected in the J-Box) Attach **Logger J-Box** to the Vertical Mast of the tripod. (secure tripod as needed)
Align the Wind Direction Sensor to North.

2. Route the Sensor cables into the J.Box and connect to the Terminal Board **See Hook-Up Drawing** for Actual connections

3. Connect the **Red (+)** Lead Wire to the +12V Battery Terminal ■
This acts as the **ON / OFF** switch to the logger.

4. The system will operate for around **10 Days on a Fully Charged Battery**
To Charge the Battery...Plug the Battery Charger into the **2 pin inline connector**, ->> then plug the Charger into an AC Power Outlet (100~240vac) or an Outdoor rated Ext.Cord
Note : The logger will be ON and Operating during charging,
or
Connect the Optional Solar Panel Charger into the 2 pin plug and Align for max Sun exposure



5. The Logger Display should come up **Wind Channels <- select ->**
To View all the current sensor reading , do the following steps below

Press the center **Select Button** and you will See AN0 Wind Speed 1.7 MPH / 34.1 max (this is the current Speed & the max for the logging period)

Press the up ▲ **Button** 3 Times to scroll to the Wind Direction screen
{ Range 0 to 360° Wind Direction } 227° (SW) shown

Press the up ▲ **Button** again 2 times and you will see
" Analog Channels" < - SELECT ->

Press the center **Select Button** and you will See A0 Input Voltage 13.55 vdc
(Reading between should be between 12 to 14 VDC)

Pressing the up ▲ **Button** to scroll thru and view channels A0 thru A7
A0 is Input voltage (battery)
* **A4 is Temperature** °F or C° , (Typical Values Shown) ->>>
* **A5 is Humidity %**
A6 is Barometric Pressure in.hg. or mb
Ignore the other Channels that are not being used A1, A2 A3,A7
(* **NOTE**: There is a 10 minute warm-up time for the T/RH sensor to stabilize
It will read correct after the 10 minute period)

At the end after A7 then " Analog Channels" < - SELECT -> will be displayed
Press up ▲ Button to See "Counter Channels" <- select ->
Press the center **Select Button** and you will See 0: ANEMO 0
Press the up ▲ **Button** 2 Times to scroll to the Rain screen
you will See 2: RAIN TODAY 0.00 IN today

The **WS-25N is Normally Set-UP Prior to Shipping** with the Following Settings

A. Date & Time of the shipping Location. (if Known)
B . 1 minute logging interval.
C . Unused channels are Not Logged., but any optional sensors are added in and programed
D. Default Units Speed is in MPH, Temp in in ˚F, Pressure is in Inches of hg., Rain ~Inches
Foreign orders units are set for Speed ~ m/s, Temp. ~˚ C , Pressure ~mb, rain ~ mm

Standard Sensors are : 200-WS-02F , 110- WS-25TH, 110-WS-25RG, 110-WS-25BP

Check and Verify the **Date and Time** , Press the up ▲ **Button** until the Date And Time Screen Shows
Refer to the Main Manual to Set or Change to Your Correct Time, Date and Logging Interval.

Insert the SD Memory Card into the memory card slot to start recording
To insert the SD™) card, place the card face up into the slot on the front panel and press the card inwards until the card clicks into place..... To remove card, press the card slightly inward and the card will release

You are Now Connected to the WS-25 and Logging Data to Memory Card.
A New File .csv will be created at the End of Each Day, (yyyy, mm, dd) (20130915.csv) Sept.15, 2013

To **View the Stored Data** Remove the Memory Card and Insert it into The USB Memory Card Reader
(The Card Reader needs to be plugged into A USB Port on Your PC)
Data is stored in a text file in Comma Separated Vertical (CSV) format.

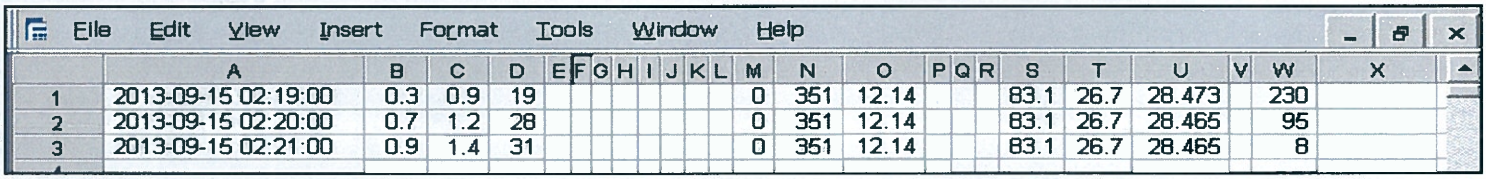
Data Record Format Information on Memory Card
There are **No Description headers generated** on the stored Data 23 Fields are generated , but only the ones being used are saved, the,,,,, is where the missing fields would appear if the were needed

Sample Data with the **6 Standard Sensors connected WS-25DL** 1 min logging, English units
Header Description and the order that they appear for the Standard values

Date and Time, Speed , Gust , Spd count,,,,, Rain , W.Dir., inVolts , Temp ˚ F, Hum %, BP inhg, cksum

2013-09-15 02:19:00, 0.3, 0.9, 19,,,,,,,, 0.00, 351, 12.14,,,, 83.1, 26.7, 28.473,, 230

2013-09-15 02:20:00,0.7,1.2,28,,,,,,,,0.00,351,12.14,,,,83.1,26.7,28.465,,95



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	2013-09-15 02:19:00	0.3	0.9	19									0	351	12.14				83.1	26.7	28.473		230	
2	2013-09-15 02:20:00	0.7	1.2	28									0	351	12.14				83.1	26.7	28.465		95	
3	2013-09-15 02:21:00	0.9	1.4	31									0	351	12.14				83.1	26.7	28.465		8	

2013-09-15 02:21:00,0.9,1.4,31,,,,,,,,0.00,351,12.14,,,,83.1,26.7,28.465,,8

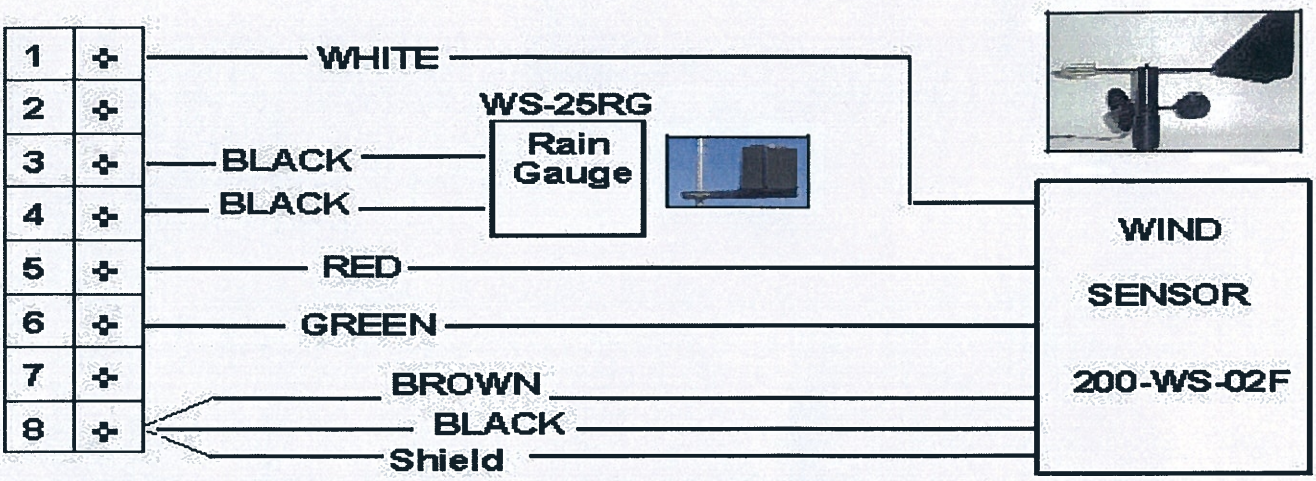
Sample on same above data imported into a Spreadsheet

The 9 pin Serial RS-232 cable can be connected to the logger for real time serial Output to a PC or Radio if needed.

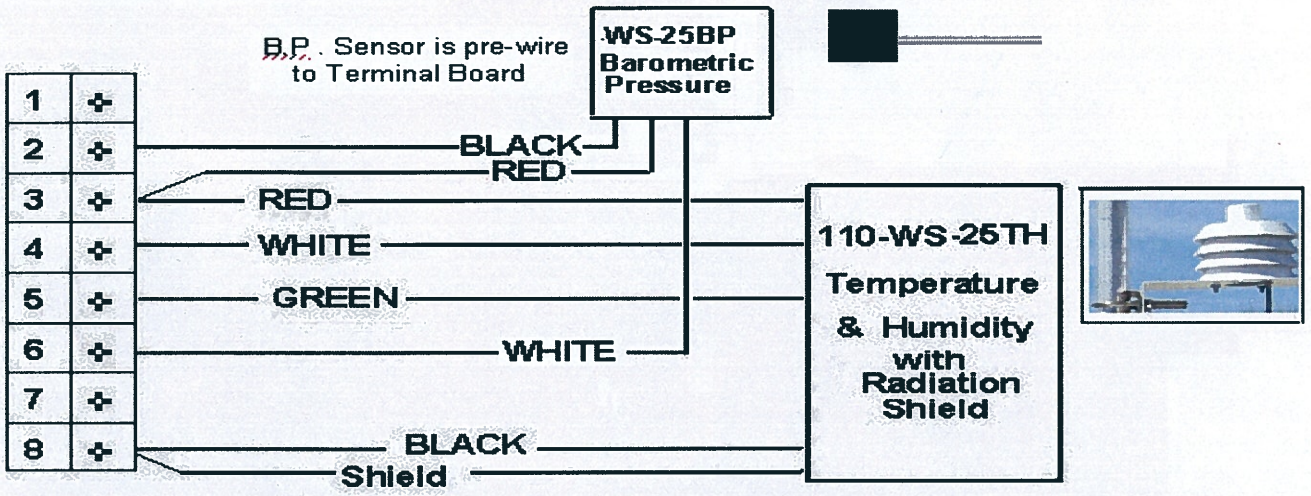
The The AC Battery Charger is located under the panel and has a viewing hole on the panel for charging Status
" AC Charger Light" Red , means Charging / Green means finished and in Maintain mode (trickle charging)

Note: The System as been sent up for Your Sensors and Units ..**DO Not Select "Restore Defaults"**
Refer to the Wind Data Logger Manual For More Detailed advanced information. Rev. Oct. - 2013

WIND & RAIN



TEMP / RH / BP Aux

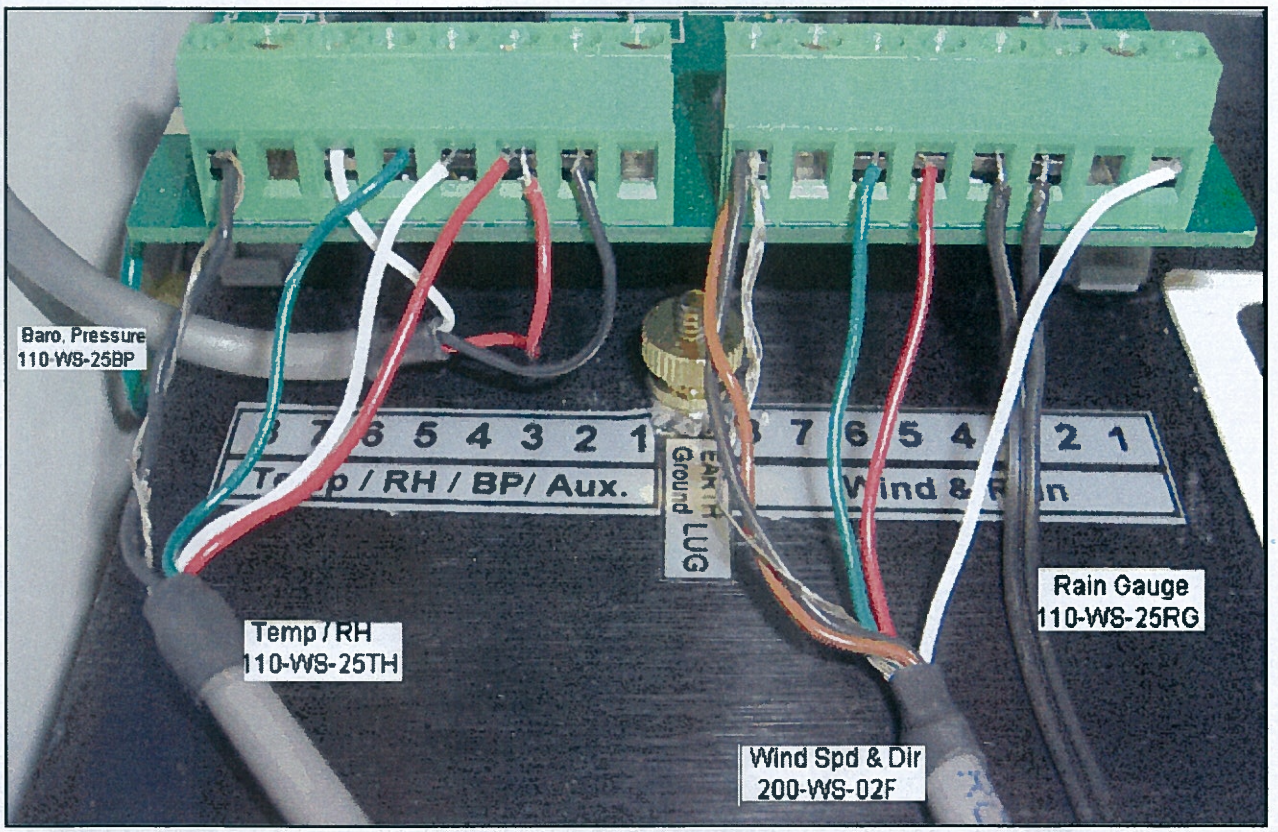


Sensor Wiring Hook-up Drawing 110-WS-25N

After connecting the wires

Pull on each wire to make sure it is connected securely

rev 10-25-2013



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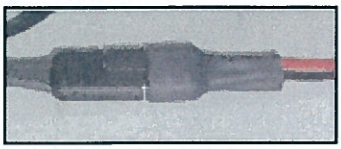

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Pressing the up ▲ **Button** to scroll thru and view channels A0 thru A7
A0 is Input voltage (battery)
* **A4 is Temperature** °F or C° , (Typical Values Shown) ->>>
* **A5 is Humidity %**
A6 is Barometric Pressure in.hg. or mb
Ignore the other Channels that are not being used A1, A2 A3,A7
(* **NOTE**: There is a 10 minute warm-up time for the T/RH sensor to stabilize
It will read correct after the 10 minute period)

At the end after A7 then " Analog Channels" < - SELECT -> will be displayed
Press up ▲ Button to See "Counter Channels" <- select ->
Press the center **Select Button** and you will See 0: ANEMO 0
Press the up ▲ **Button** 2 Times to scroll to the Rain screen
you will See 2: RAIN TODAY 0.00 IN today

The **WS-25N is Normally Set-UP Prior to Shipping** with the Following Settings

A. Date & Time of the shipping Location. (if Known)
B . 1 minute logging interval.
C . Unused channels are Not Logged., but any optional sensors are added in and programed
D. Default Units Speed is in MPH, Temp in in ˚F, Pressure is in Inches of hg., Rain ~Inches
Foreign orders units are set for Speed ~ m/s, Temp. ~˚ C , Pressure ~mb, rain ~ mm

Standard Sensors are : 200-WS-02F , 110- WS-25TH, 110-WS-25RG, 110-WS-25BP

Check and Verify the **Date and Time** , Press the up ▲ **Button** until the Date And Time Screen Shows
Refer to the Main Manual to Set or Change to Your Correct Time, Date and Logging Interval.

Insert the SD Memory Card into the memory card slot to start recording
To insert the SD™) card, place the card face up into the slot on the front panel and press the card inwards until the card clicks into place..... To remove card, press the card slightly inward and the card will release

You are Now Connected to the WS-25 and Logging Data to Memory Card.
A New File .csv will be created at the End of Each Day, (yyyy, mm, dd) (20130915.csv) Sept.15, 2013

To **View the Stored Data** Remove the Memory Card and Insert it into The USB Memory Card Reader
(The Card Reader needs to be plugged into A USB Port on Your PC)
Data is stored in a text file in Comma Separated Vertical (CSV) format.

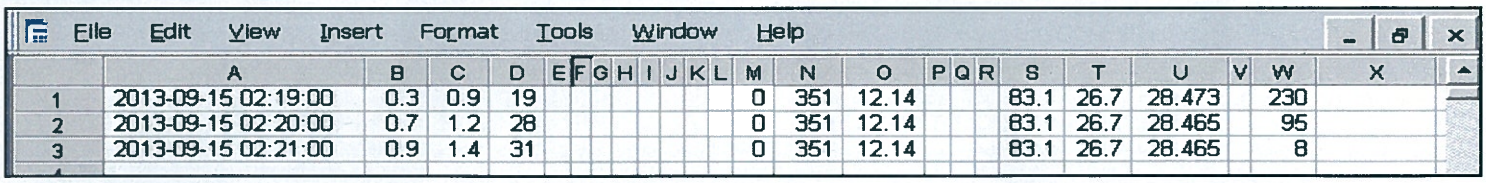
Data Record Format Information on Memory Card
There are **No Description headers generated** on the stored Data 23 Fields are generated , but only the ones being used are saved, the,,,,, is where the missing fields would appear if the were needed

Sample Data with the **6 Standard Sensors connected WS-25DL** 1 min logging, English units
Header Description and the order that they appear for the Standard values

Date and Time, Speed , Gust , Spd count,,,,, Rain , W.Dir., inVolts , Temp ˚ F, Hum %, BP inhg, cksum

2013-09-15 02:19:00, 0.3, 0.9, 19,,,,,,,,, 0.00, 351, 12.14,,,, 83.1, 26.7, 28.473,, 230

2013-09-15 02:20:00,0.7,1.2,28,,,,,,,,,0.00,351,12.14,,,,83.1,26.7,28.465,,95



File Edit View Insert Format Tools Window Help

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	2013-09-15 02:19:00	0.3	0.9	19									0	351	12.14				83.1	26.7	28.473		230	
2	2013-09-15 02:20:00	0.7	1.2	28									0	351	12.14				83.1	26.7	28.465		95	
3	2013-09-15 02:21:00	0.9	1.4	31									0	351	12.14				83.1	26.7	28.465		8	

2013-09-15 02:21:00,0.9,1.4,31,,,,,,,,,0.00,351,12.14,,,,83.1,26.7,28.465,,8

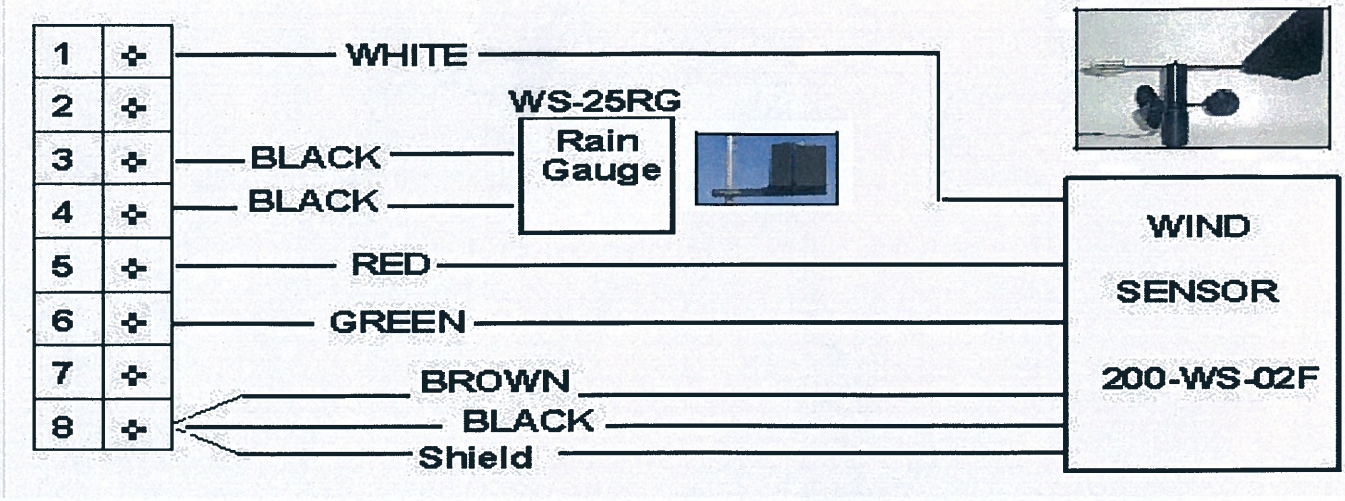
Sample on same above data imported into a Spreadsheet

The 9 pin Serial RS-232 cable can be connected to the logger for real time serial Output to a PC or Radio if needed.

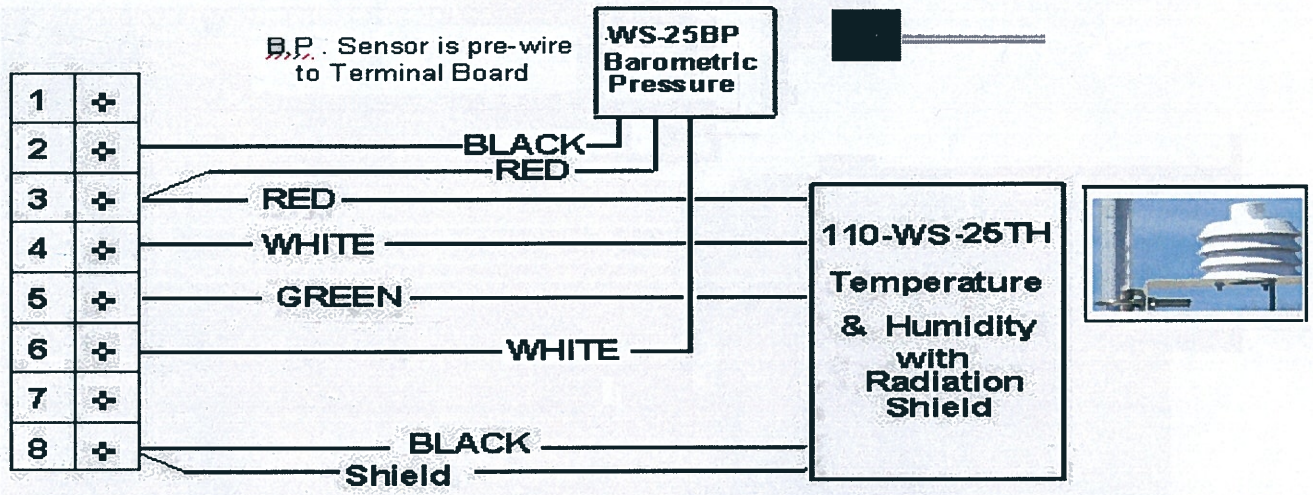
The The AC Battery Charger is located under the panel and has a viewing hole on the panel for charging Status
" AC Charger Light" Red , means Charging / Green means finished and in Maintain mode (trickle charging)

Note: The System as been sent up for Your Sensors and Units ..**DO Not Select "Restore Defaults"**
Refer to the Wind Data Logger Manual For More Detailed advanced information. Rev. Oct. - 2013

WIND & RAIN



TEMP / RH / B P Aux

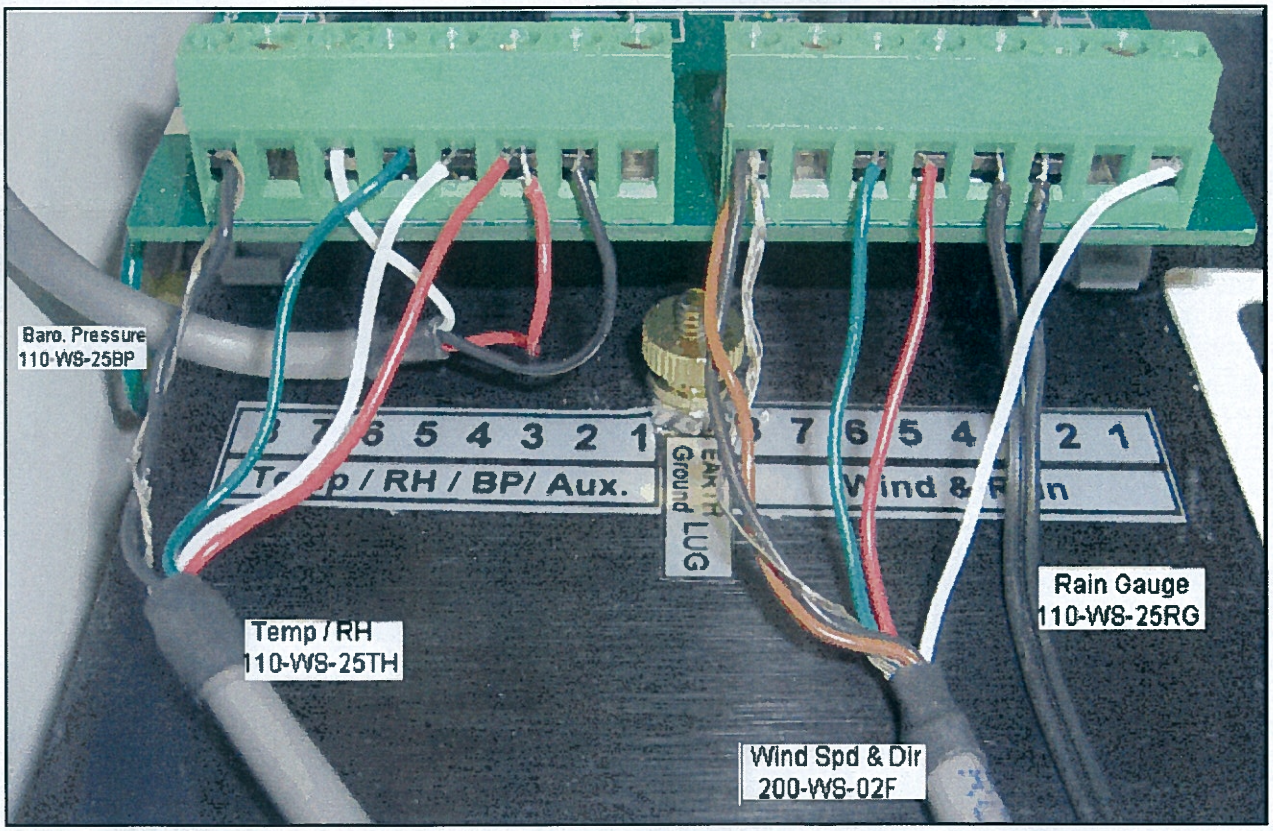


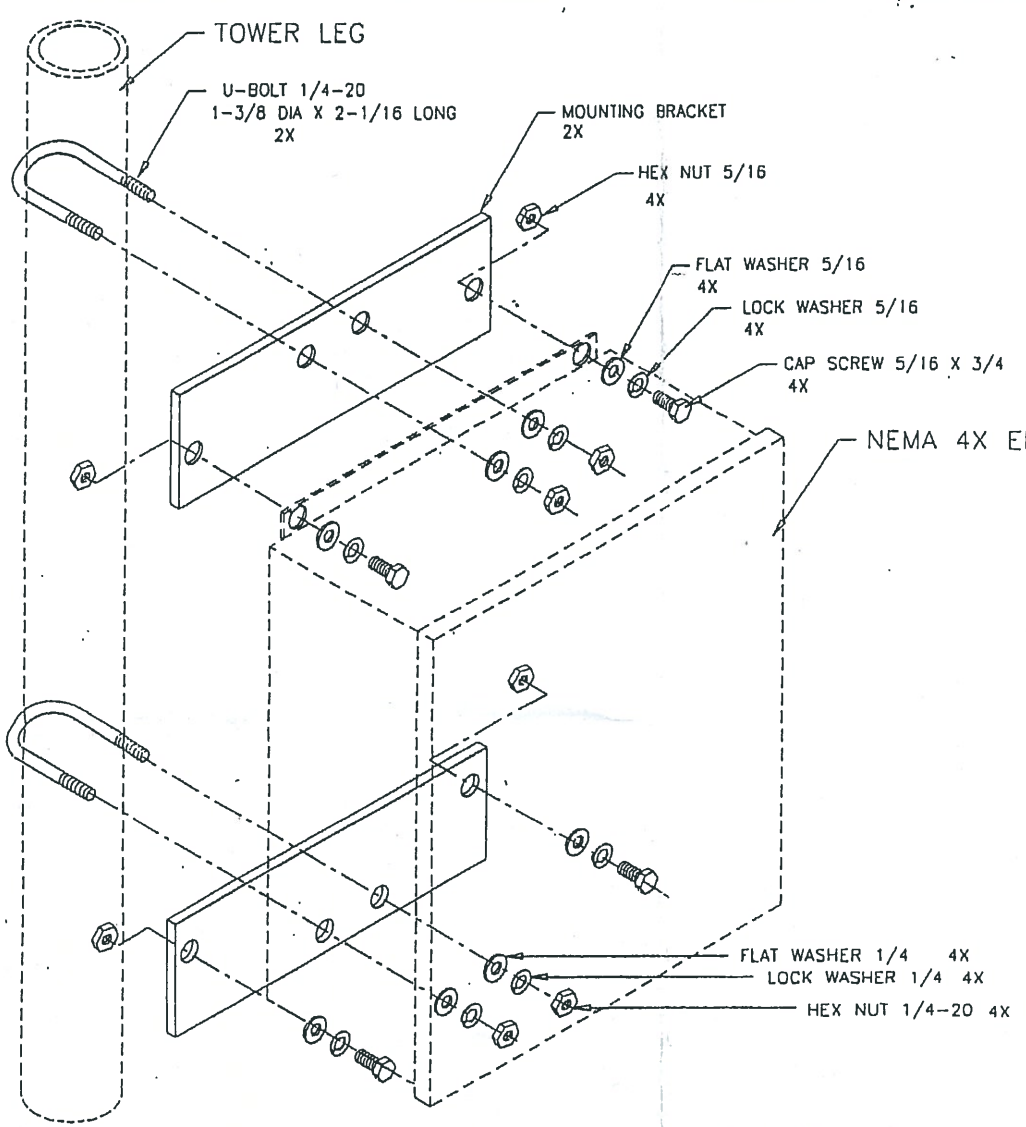
Sensor Wiring Hook-up Drawing 110-WS-25N

After connecting the wires

Pull on each wire to make sure it is connected securely

rev 10-25-2013

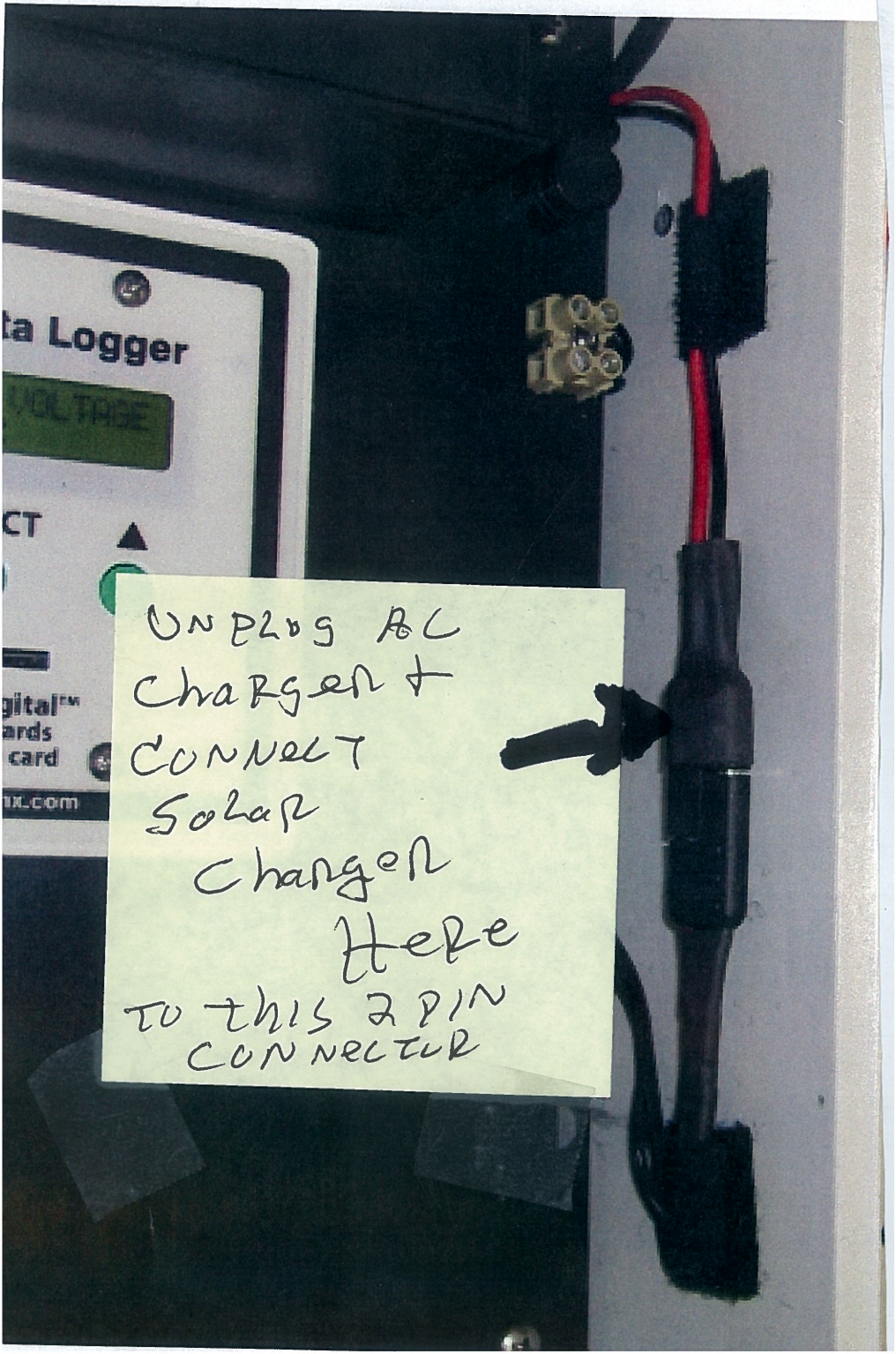




TYPICAL VIEW

NOTE – 1. BOTTOM BRACKET IS INVERTED COMPARED TO TOP BRACKET.
2. ROTATE BOX ON TOWER LEG SO THAT BACK OF BOX IS PARALLEL TO THE TWO OPPOSITE TOWER LEGS.

TITLE	ASSEMBLY, INSTALLATION ENCLOSURE, MODEL 395 SERIES
MODEL USAGE	SHEET 1 OF 1
BY RN	DWG. NO. 930306
DATE 3-04-93	


ta Logger
CT
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card
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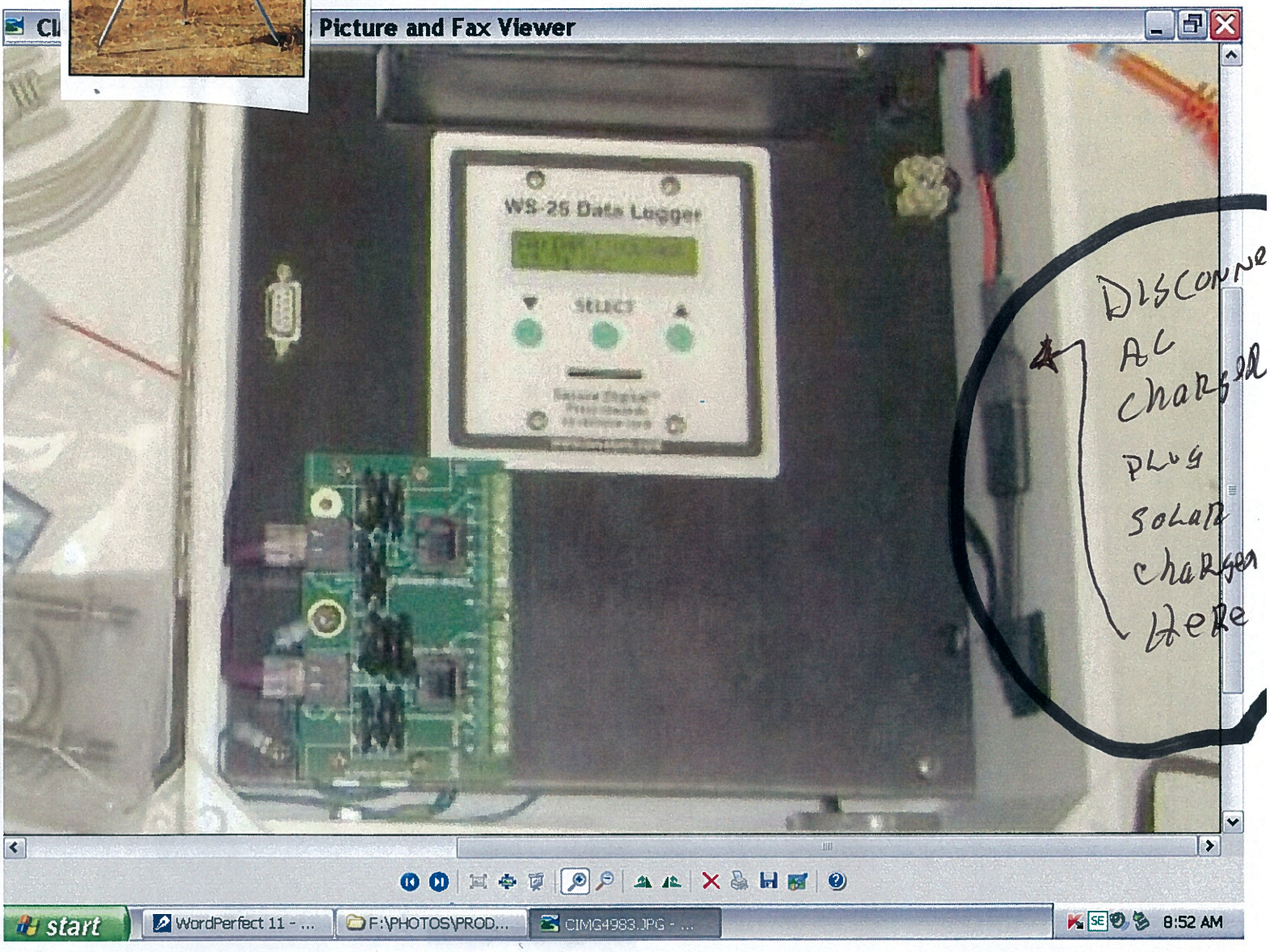
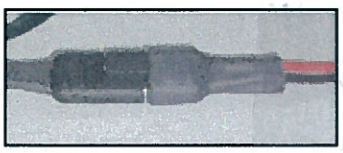
UNPLUG AC
Charger +
CONNECT
Solar
Charger
Here
TO THIS 2 PIN
CONNECTOR



4. The system will operate for around **10 Days on a Fully Charged Battery**
To Charge the Battery...Plug the Battery Charger into the **2 pin inline connector**, ->> then plug the Charger into an AC Power Outlet (100~240vac) or an Outdoor rated Ext.Cord
Note : The logger will be ON and Operating during charging,



or

Connect the Optional Solar Panel Charger into the 2 pin plug and Align for max Sun exposure

7 Function Digital Multimeter

Novalynx has provided This Digital Multimeter at No Charge with the WS-16 Weather Station.

The Meter Will Help to Analyze and Test the Data Logger and Weather Sensors or any Problems that May Occur

The included RS-232 Test Light is used to Verify the RS-232 Signal Output.

The Meter Can Be used to Measure the +12 Volt and the +5 V power
from the WS-16
On Nema Box Versions, It Can Be used to Measure the 12 V Battery and Battery Charger Voltages,

All of The **Weather Sensors** Can Be **Functionally Tested and Checked**

1. **Wind Sensor** ~ Measure the Potentiometer Resistance with the Ohmmeter
   Measure the Speed Signal Output (Switch closure or AC voltage)

2. **Rain Gauge** ~ Use the Ohmmeter to test the Switch closure output for Each Tip

3. **Temp/RH Sensor** ~ Use the voltmeter to check the 0-1vdc Output for the Temp Sensor
   Use the voltmeter to check the 0-1vdc Output for the RH Sensor
4. **Temperature** ~ Use the Ohmmeter to measure the Thermistor Resistance vs. Temperature
5. **Barometric Pressure** ~Use the voltmeter to check the 0 to 5volt Output vs. Pressure

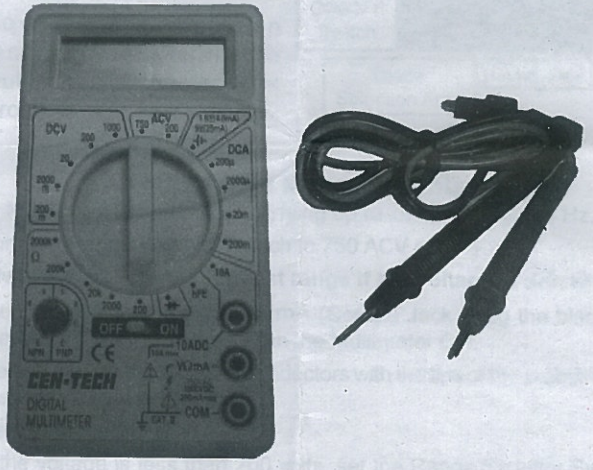
The Standard Weather Sensor Manuals are included on the Quick Start CD

CEN-TECH®

7 FUNCTION DIGITAL MULTIMETER

Model 69096

OPERATING INSTRUCTIONS



Visit our Web site at http://www.harborfreight.com

REV 12a

For technical questions and replacement parts, please call 1-800-444-3353

Specifications

Frequency	45-450 Hz
DC Amps	Ranges: 200µA/2000µA/20mA/200mA, 10A
Accuracy	(@200µA-200mA) 1.2%±2D; (@10A) 3%±2D
DC Voltage	Ranges: 200mV/2000mV/20/200/1000V
Accuracy	(@200mV) 0.5%±1D; (@2000mV-200V) 1.0%±1D; (@1000V) 1.0%±2D
AC Voltage	Ranges: 200/750V
Accuracy	(45-450 Hz) 1.2%±10D
Resistance	Ranges: 200/2000/20K/200K/2000K Ohm
Accuracy	(@200-200K Ohm) 0.8%±2D; (@2000K Ohm) 1.0%±2D;
Sampling Rate	2.5 times/Second
Overload Protection	Fast-Acting 500mA/250V Fuse
Operating Temperature	Range: 32° - 104° F
Display	$^1/_2$" high 3-$^1/_2$-digit LCD
Battery	One 9 V (included)
Weight	.45 lb.
Features	29-1/2" Test Leads, Transistor (NPN and PNP) Testing Function, Battery Testing Function, and Automatic Polarity and Zero Adjust

Save This Manual

You will need the manual for the safety warnings and precautions, and operating and maintenance procedures. Keep your invoice with this manual. Write the invoice number on the inside of the front cover. Keep the manual and invoice in a safe and dry place for future reference.

Safety Warnings and Precautions

WARNING: When using tool, basic safety precautions should always be followed to reduce the risk of personal injury and damage to equipment.

Warnings continued on page 3.

Read all instructions before using this tester!

1. **Avoid working alone**. If an accident happens, an assistant can bring help.
2. **Keep work area clean**. Cluttered areas invite injuries.
3. **Avoid electrical shock.** Use extreme caution when using this tool near uninsulated conductors or bus bars. Prevent body contact with grounded surfaces such as pipes, radiators, ranges, and cabinet enclosures when testing voltages.
4. **Avoid damaging meter**. Use only as specified in this manual.
5. **Observe work area conditions**. Do not test voltages in damp or wet locations. Don't expose to rain. Keep work area well lit.
6. **Keep children away**. Children must never be allowed in the work area. Do not let them handle machines, tools, or extension cords.
7. **Store idle equipment**. When not in use, tools must be stored in a dry location to inhibit rust. Always lock up tools and keep out of reach of children.
8. **Dress properly**. Do not wear loose clothing or jewelry as they can be caught in moving parts. Protective, electrically nonconductive clothes and nonskid footwear are recommended when working. Wear restrictive hair covering to contain long hair.
9. **Use eye protection**. Always wear ANSI approved impact safety goggles.
10. **Do not overreach**. Keep proper footing and balance at all times. Do not reach over or across electrical cables or frames.
11. **Maintain tools with care**. Ensure multimeter has a fresh battery. Inspect test leads periodically and, if damaged, have them repaired by an authorized technician.
12. **Stay alert**. Watch what you are doing, use common sense. Do not operate any tool when you are tired.
13. **Check for damaged parts**. Before using any tool, any part that appears damaged should be carefully checked to determine that it will operate properly and perform its intended function. Check for any broken parts and any other condition that may affect proper operation. Any part that is damaged should be properly repaired or replaced by a qualified technician. Do not use the tool if any switch does not operate properly.

15. **Replacement parts and accessories**. When servicing, use only identical replacement parts. Use of any other parts will void the warranty. Only use accessories intended for use with this tool. Approved accessories are available from Harbor Freight Tools.
16. **Do not operate tool if under the influence of alcohol or drugs**. Read warning labels on prescriptions to determine if your judgment or reflexes are impaired while taking drugs. If there is any doubt, do not operate the tool.
17. **We recommend that only a licensed electrician work on high-voltage or other potentially dangerous circuits.**

Note: Performance of this tool may vary depending on condition of internal battery

Warning: The warnings, cautions, and instructions discussed in this instruction manual cannot cover all possible conditions and situations that may occur. It must be understood by the operator that common sense and caution are factors which cannot be built into this product, but must be supplied by the operator.

Warning: This product contains or produces chemicals, including lead, known to the State of California to cause cancer and birth defects (or other reproductive harm).
(California Health & Safety Code 25249.5 et seq.)

Unpacking

When unpacking, make sure the following parts are included: Digital Multimeter, and black and red Test Leads. If any parts are missing or broken, please call Harbor Freight Tools at the number on the cover of this manual. If any part of the machine is missing or broken, please call Harbor Freight Tools at the number on the front cover as soon as possible.

Operation

WARNING: ELECTRICAL SHOCK CAN CAUSE DEATH OR INJURY. AVOID TOUCHING EXPOSED CONDUCTORS OF ELECTRICITY.

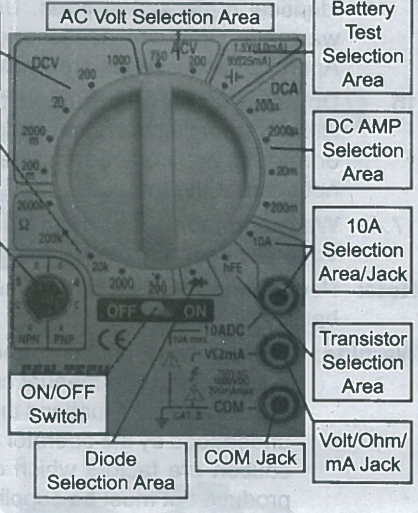
Additional Multimeter Precautions

1. Do not test voltage on AC circuits higher than 750 volts.
2. Do not test voltage on DC circuits higher than 1000 volts.
3. Do not test current on circuits higher than 10 amps.

4. Be careful not to apply voltage to the Test Leads when they are connected to the COM (Bottom) and VΩmA (Center) Jacks and the Multimeter is in an Ohms testing setting. Damage can occur to the multimeter or the fuse may blow.

5. Do not switch between testing modes with the multimeter connected to a circuit.

Control Layout



AC Voltage Measurements

Measure AC conductors carrying up to 750 VAC, 45-450 Hz.

1. Turn the Range Selector Switch to 750 ACV setting.
   Always start with the highest range if the voltage is unknown.
2. Plug the red lead into the VΩmA (Center) Jack. Plug the black lead into the COM (Bottom) Jack. Switch the Multimeter ON.
3. Carefully touch the exposed conductors with the tips of the probes to measure the voltage (not amperes).
4. Read measurement.
   If the voltage is less than 200 volts, set the Range Selector Switch to the lower range.
5. When testing is complete, remove Test Leads and store with multimeter.

DC Voltage Measurements

Measure DC conductors carrying up to 1000 VDC.

1. Turn the Range Selector Switch to 1000 DCV setting.
2. Follow the directions above under "AC Voltage Measurements", only use the DC settings instead.

DC Current Measurements

Measure DC conductors carrying up to 10 amperes.

1. Turn the Range Selector Switch to the 10A position.
   Always start with the highest range if the amperage is unknown.
2. Plug the red lead into the 10A (Top) Jack. Plug the black lead into the COM (Bottom) Jack. Switch the Multimeter ON.
3. Carefully touch the exposed conductors with the tips of the probes to measure the amperage.

Note: Amperage is always tested in series with the circuit under test.

4. Read measurement.
   If the reading is less than .2 AMPs, switch the red lead to the VΩmA (Center) Jack and set the Range Selector Switch to the 200 mA setting.
5. When testing is complete, remove Test Leads and store with multimeter.

Resistance Measurements

Measure circuit resistance up to 2000K Ohms.

WARNING: NEVER measure resistance on a circuit with voltage running through it.

1. Turn the Range Selector Switch to the 200 mA position.
2. Plug the red Test Lead into the VΩmA (Center) Jack. Plug the black Test Lead into the Com (Bottom) Jack. Switch the Multimeter ON. Short the Test Leads together. The meter should read "0" Ohms
3. Touch the exposed conductors with the tips of the Test Leads.
4. Read measurement.
   If the reading is "1", set the Range Selector Switch to the next higher Ohm (Ω) position.

Transistor (hFE) Measurements

Test transistors to ensure proper function.

1. Turn the Range Selector Switch to the hFE position. Switch the Multimeter ON.
2. Insert the transistor pins into the appropriate hFE jack (NPN or PNP) according to the EBC (Emitter, Base, Collector) sequence.
3. The meter will show the approximate hFE value.

Diode Measurement

Test the voltage drop in diodes.

1. Turn the Range Selector Switch to the Diode (→|) position.
2. Plug the red Test Lead into the VΩmA (Center) Jack. Plug the black Test Lead into the Com (Bottom) Jack. Switch the Multimeter ON.
3. Connect the red probe to the anode of the diode and the black to the cathode.

4. The approximate forward voltage drop of the diode will be displayed in mV. If the connection is reversed only "1" will be shown.

Battery Charge Measurement

Test the amount of charge left in batteries.

NOTE: This setting is for testing the charge of small 9V or 1.5V batteries only. Never use this setting to test automotive or lead-acid batteries. The high current could cause damage to the meter and/or cause severe personal injury. Use the appropriate DC Voltage setting to test the open current voltage of such batteries instead.

1. Turn the Range Selector Switch to the Battery (⊣⊢) position.
2. Plug the red Test Lead into the VΩmA (Center) Jack. Plug the black Test Lead into the Com (Bottom) Jack. Switch the Multimeter ON.
3. Connect the red probe to the positive terminal of the battery and the black to the negative terminal.
4. The battery amperage under a load of 370 mΩ will be displayed to a resolution of .1mA.
5. Normal amperage: For a standard 9V (6LR61) battery = 25 mA
   For a 1.5 V "AA" (LR6) battery = 4 mA

Maintenance

1. Wipe unit with a slightly damp cloth using a light detergent. Do not use solvents or abrasives.
2. Remove battery if not in use for long periods.
3. Store unit in a dry location.
4. Other than the battery and fuse, there are no replaceable parts on this unit. Repairs should be done by a qualified technician.

Battery/Fuse Replacement

To replace the battery or fuse:

1. Remove the Test Leads from the multimeter.
2. Turn the unit over.
3. Remove both screws using a cross head screwdriver.
4. Remove back cover.
5. Pull battery/fuse out of unit and replace with the same.
   (9V battery or 500mA/250V fast-acting fuse)
6. Replace cover and retighten screws.

NOTE: No replacement parts are available for this tool.

APPENDICES

Appendix 9.2 Surface water and sediment monitoring plan

ARCADIS
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Imagine the result

Compagnie des bauxites de Guinée (CBG)

CBG Production Expansion Project

Surface Water and Sediment Monitoring Plan

September 2015

ARCADIS

Helen Manolopoulos, Ph.D.
Project Scientist

Stacey Fernandes, M.A.Sc.
Senior Environmental Engineer

Surface Water and Sediment Monitoring Plan

CBG Production Expansion Project

Prepared for:
Compagnie des bauxites de Guinée (CBG)

Prepared by:
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Tel 905 764 9380
Fax 905 764 9386

Our Ref.:
350854-003

Date:
September 2015

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1. INTRODUCTION

1.1 BACKGROUND

CBG (Compagnie des bauxites de Guinée) is a mining company jointly owned by the Government of Guinea and Halco Mining (Alcoa, Rio Tinto Alcan and Dadco). CBG is currently considering the expansion of its bauxite production (referred to as the *Project*) from the current annual capacity of 13.5 MTPA (million tonnes per annum at 3% moisture) up to 18.5 MTPA by 2019, and ultimately up to 27.5 MTPA by 2027.

In support of the planned Project, ARCADIS Canada Inc. (formerly SENES Consultants) was retained by EEM to assess the potential effects of the Project activities on surface water and sediment quality in the Kamsar and Sangarédi areas. The surface water and sediment assessments formed part of the Environmental and Social Impact Assessment (ESIA) submitted to the Government of Guinea by CBG in January 2015.

1.2 PREVIOUS MONITORING EFFORTS

As part of the assessments for the ESIA, CBG completed monitoring of surface water and sediment quality in April and June of 2014 in the Kamsar and Sangarédi study areas, respectively. ARCADIS assisted EEM and CBG in the development of the field work plan and advised CBG on the purchase of monitoring and sampling equipment. The basic approach consisted of the following:

- One time collection (during high tide) of co-located surface water and sediment samples from the Dougoufissa River and the Rio Nuñez estuary at the Kamsar Port area where the processing plant is located.
    - The intent of the sampling was to capture conditions in the Dougoufissa River upstream of the processing facility as well as downstream in the mouth of the river and further into the estuary; however, given the strong tidal effects, homogeneous constituent levels were observed throughout the river.
- One time collection of co-located surface water and sediment samples from a number of streams in the Sangarédi mining area including the Thiapikouré, Pora, Lafou, Boundou Wandé, and Cogon rivers within the Cogon River watershed, as well as streams near the Koobi plateau to the west within the Tinguilinta River watershed, the Dalagal and Mooule plateaus to the north, and a stream running through the Sangarédi stockpile area.

- The intent of the sampling was to capture conditions in the main rivers within the Cogon River watershed upstream and downstream of mining activities, as well as to capture baseline conditions in areas where mining will be expanded in the future.

ARCADIS also provided work instructions for conducting the water and sediment sampling and for calibrating the multi-probe instrument. Sampling supplies, including pre-washed, acid rinsed bottles, prepped with preservative acid (in the case of samples collected for metal determinations) for surface water samples and glass jars with Teflon lined lids for sediment samples, zip-lock bags and chain of custody forms were all provided by Maxxam Analytics in Mississauga, Canada, and shipped to Guinea. CBG staff carried out all field monitoring activities and were responsible for shipping the collected samples back to Canada for analysis. As indicated, analysis of the surface water and sediment samples was completed by Maxxam Analytics, which is an accredited Canadian laboratory.

1.2.1 Sampling Equipment

The surface water sampling equipment consisted of the following:

- One (1) YSI Professional Plus (Pro Plus) instrument equipped with a Quatro 4-port cable to collect in-situ measurements of pH, temperature, conductivity, dissolved oxygen in surface water as well as ammonium / ammonia in freshwater;
- Calibration solutions for the Pro Plus instrument including pH buffer (pH 4, 7 and 10), conductivity (12880 [illegible] and ammonia (1 mg/L and 100 mg/L) solutions; and,
- One (1) Wildco Horizontal Beta acrylic, water sampler with a 3.2 L capacity and equipped with a 100 ft (30.5 m) polyester line.

The sediment sampling equipment consisted of the following:

- One (1) Wildco 6x6" Petite Ponar dredge sampler constructed of stainless steel with zinc plated steel arms and weights.

1.2.2 Monitoring Locations

As part of the original field work plan, ARCADIS provided CBG with a list of recommended monitoring locations of which the ones shown in Figure 1 were sampled at Kamsar and the ones shown in Figure 2 were sampled at Sangarédi. As was

mentioned previously, all monitoring locations in both areas were sampled for both surface water and sediment. In addition, Figure 2 shows the locations of two wells that were sampled near the villages of Hore Lafou and Hamdalaye in the mining area. Sampling was conducted over two campaigns, the first at Kamsar in April 2014 and the second at Sangarédi in June 2014.

1.3 SCOPE OF THIS PLAN

Subsequent to the receipt of technical review comments on the ESIA provided by Ramboll Environ (on behalf of the IFC) and discussions with EEM, ARCADIS has developed this current monitoring plan to detail the methodologies to be used in the collection of additional surface water and sediment samples that are needed to augment the existing data set and to more accurately characterize existing conditions in the two study areas.

CBG will be responsible for all field monitoring activities going forward; however, ARCADIS and EEM are providing technical and logistical assistance during the initiation phase of the monitoring plan (September to November 2015). As a starting point, this plan has been developed around the initial phase of CBG's planned production increase to 18.5 MTPA (year 2019). During this phase of the Project, production activities in the Sangarédi area will be located nearby CBG's existing mining operations, with some expanded activities near Hamdalaye and south of Sangarédi (see Figure 5).

The monitoring plan is intended to be adaptive, in order to allow for CBG monitoring activities to expand to reflect increased production and new information gathered through monitoring. It is anticipated that specific aspects of the monitoring plan (e.g., number and location of monitoring locations and sampling frequency) will be re-evaluated by CBG as monitoring progresses and more information becomes available.

The monitoring plan includes the following:

- water and sediment sampling locations in both study areas (Kamsar and Sangarédi);
- the sampling strategy to be used at each site (i.e., number of samples of each type, at each location); and,
- the laboratory analyses to be conducted on each type of sample.

Figure 1 2014 Water and Sediment Sampling Locations at Kamsar Port Area

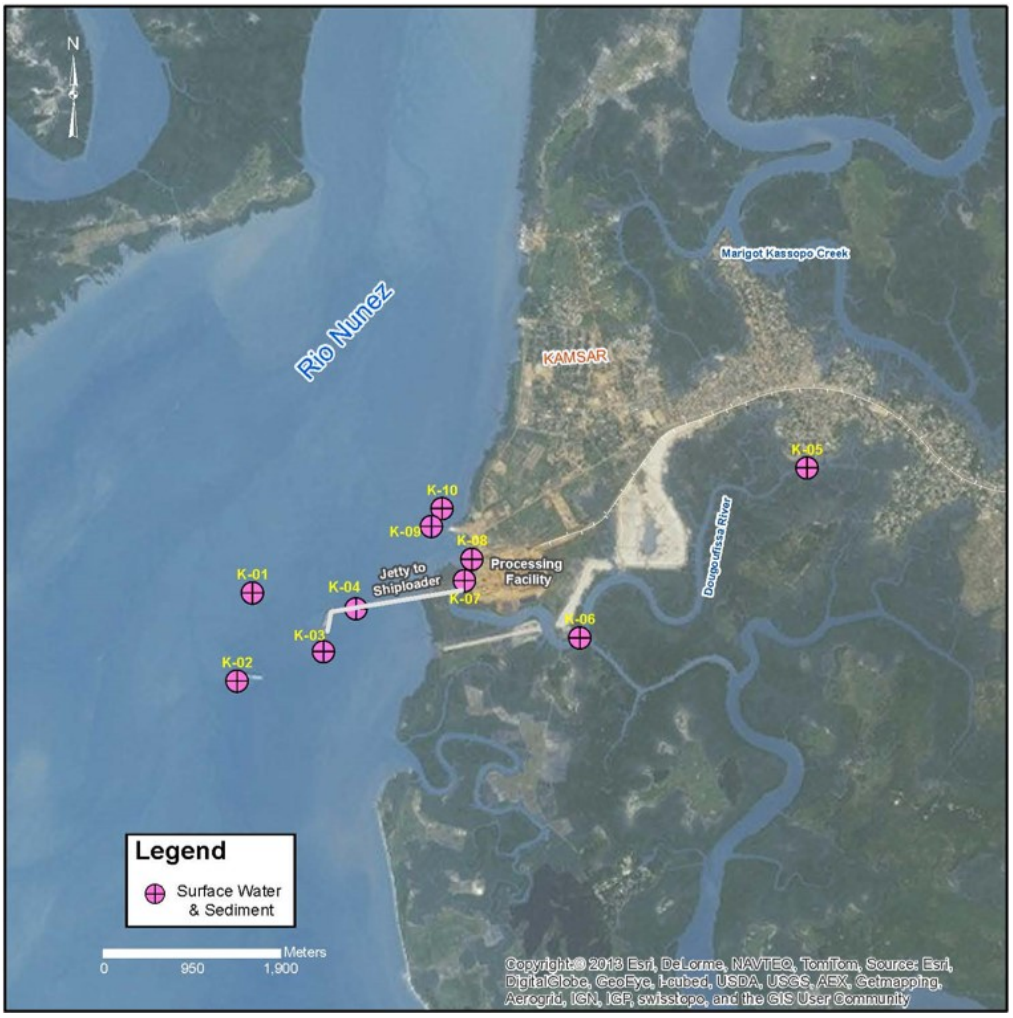
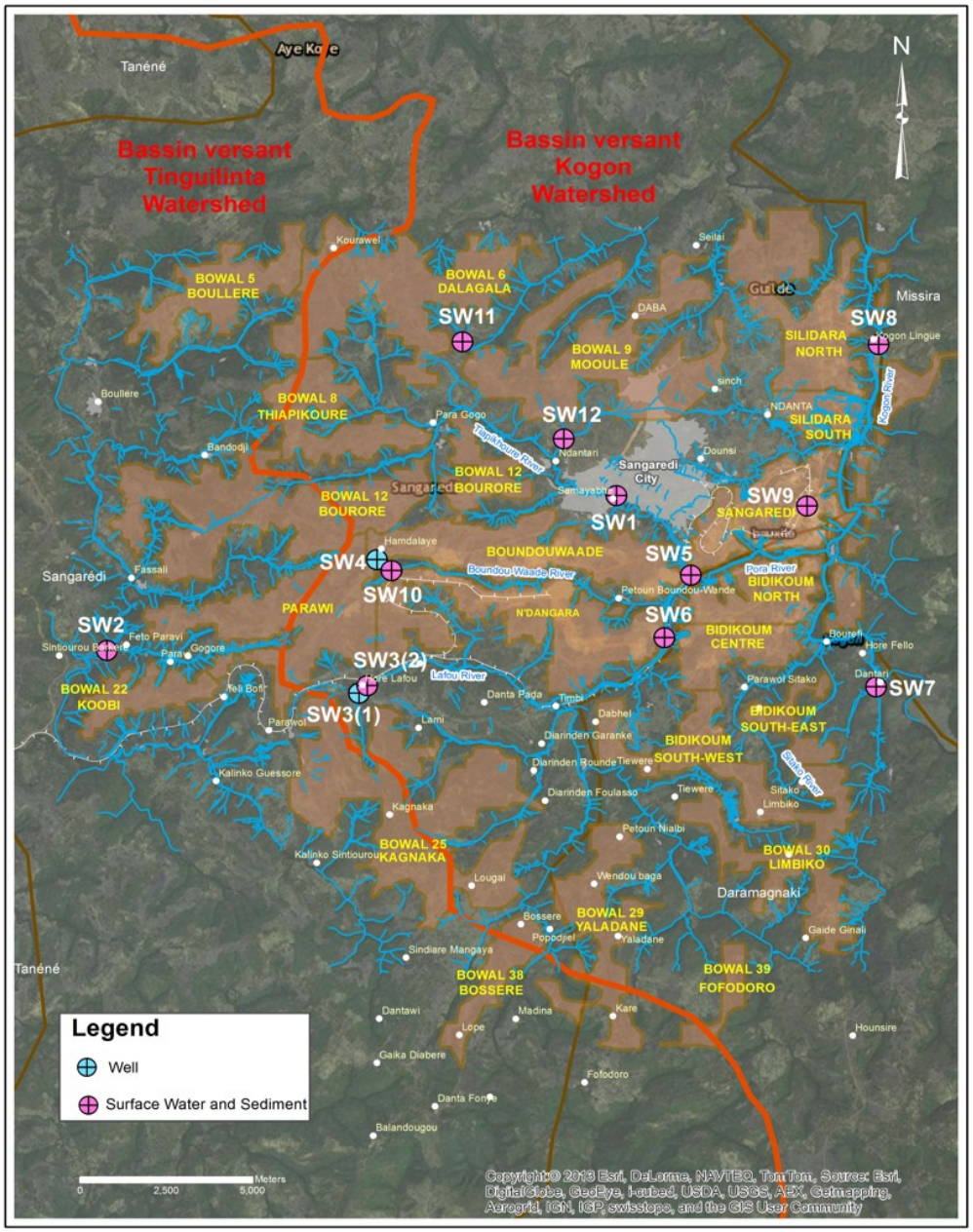


Figure 2 2014 Water and Sediment Sampling Locations at Sangarédi Mining Area



2. STUDY AREAS

2.1 KAMSAR PORT AREA

The Kamsar study area is located within the Rio Nuñez estuary on the Atlantic Ocean where fresh waters from the Rio Nuñez mix with marine waters flowing into creeks and rivers during high tide. The watershed of the Rio Nuñez covers an area of approximately 8,500 km^2 and includes the watershed of the Tinguilinta River upstream of Boké and other small rivers. The port facilities mainly fall within the catchment of the Dougoufissa River, a tributary of the Rio Nuñez, which flows in a westerly direction along the southern edge of Kamsar and drains into the estuary in front of the processing facility (Knight Piésold 2008). The processing facility was built in the early 1970s and includes unloading, crushing, drying and shipping facilities for bauxite export to refineries around the world.

The coast of Guinea experiences a semi-diurnal tidal pattern with two almost equal high tides and two low tides each day. At Kamsar, the tidal range is around 5 m and the tidal influence extends inland as far as Boké, which is 100 km inland from the river mouth (Domain and Bah 2000; Rossi *et al.* 2000). Flows and water levels in the port are strongly influenced by the tides. Surface waters in the port are directly and profoundly influenced by both the tides and the proximity of the estuary to the Atlantic Ocean, resulting in saline and turbid (suspended sediment-rich) waters. Based on the salinity distribution, the Rio Nuñez estuary is considered to be “well-mixed” (Knight Piésold 2008).

2.2 SANGARÉDI MINE AREA

Guinea has distinct wet and dry seasons lasting from May to October and from November to April, respectively. The rainy season which peaks in August, has a monthly rainfall average of more than 500 mm but monthly amounts are very variable at the beginning and end of the season (Rossi *et al*. 2000). Due to the abundant precipitation, an extensive river network has developed within the mining area which mainly falls within the watershed of the Cogon River with rivers such as the Thiapikouré, Boundou Wandé, Lafou, and Pora draining eastward to the Cogon River (see Figure 5). A watershed divide occurs in the west end of the study area with streams captured within the Tinguilinta River watershed flowing westward toward the Tinguilinta River. The Tinguilinta River drains an area of 1,891 km^2 and flows westward to Boké before joining the Rio Nuñez which flows into the Atlantic Ocean in the vicinity of Kamsar (Knight Piésold 2008).

With respect to the main rivers within the mining area, the Boundou Wandé River runs through the middle of the current footprint of the mine operations, the Thiapikouré River to the northwest, and the Lafou River parallel to the operations to the south. As mentioned, all three rivers drain eastward into the Pora River, which in turn flows into the Cogon River, the major river in the region. The Cogon River flows northwest to the border with Guinea-Bissau (379 km) and then southwest until it reaches the Rio Komponi estuary in the Atlantic Ocean.

3. FIELD PROGRAM

During the initial phase of the field program (September – November 2015), all surface water and sediment samples will be shipped from Guinea to a laboratory in Canada (Maxxam Analytics, Mississauga, Ontario) for analyses. During this period, sampling supplies (i.e., pre-washed, acid rinsed water bottles, preservative acid, glass sediment jars, zip-lock bags, coolers and chain of custody forms) will also be prepared and provided by Maxxam Analytics and shipped to Guinea. ***CBG will need to identify a laboratory to provide ongoing support for chemical analysis moving forward with the monitoring program; CBG will also need to assume the responsibility of ordering and obtaining sampling supplies from the laboratory and shipping samples to the laboratory for analysis.***

It is recommended that for the first year of the field program (September 2015 to 2016), monitoring for surface water (flow and field measurements and quality) and sediment be completed at a monthly frequency to capture seasonal variations that will provide a more accurate characterization of existing conditions within each study area (Kamsar and Sangarédi). Given the strong tidal effects in the port area and the alternating high and low river flows and water levels during the wet and dry seasons in the mining area, monthly sampling is expected to capture significant variations in parameter levels in water and sediment throughout the year. After the first year, data collected through the monitoring program and updated information describing the ongoing expansion of mining activities, can be used to reassess the locations of monitoring stations, the sampling frequency and parameters analyzed.

3.1 FLOW MONITORING

Flow monitoring on streams traversing the mining area was not completed during the 2014 water monitoring program but will be done for the current program to obtain estimates of stream discharge rates that will help refine the water balance for the mine site. Suitable flow monitoring stations will be identified during the initiation phase of the

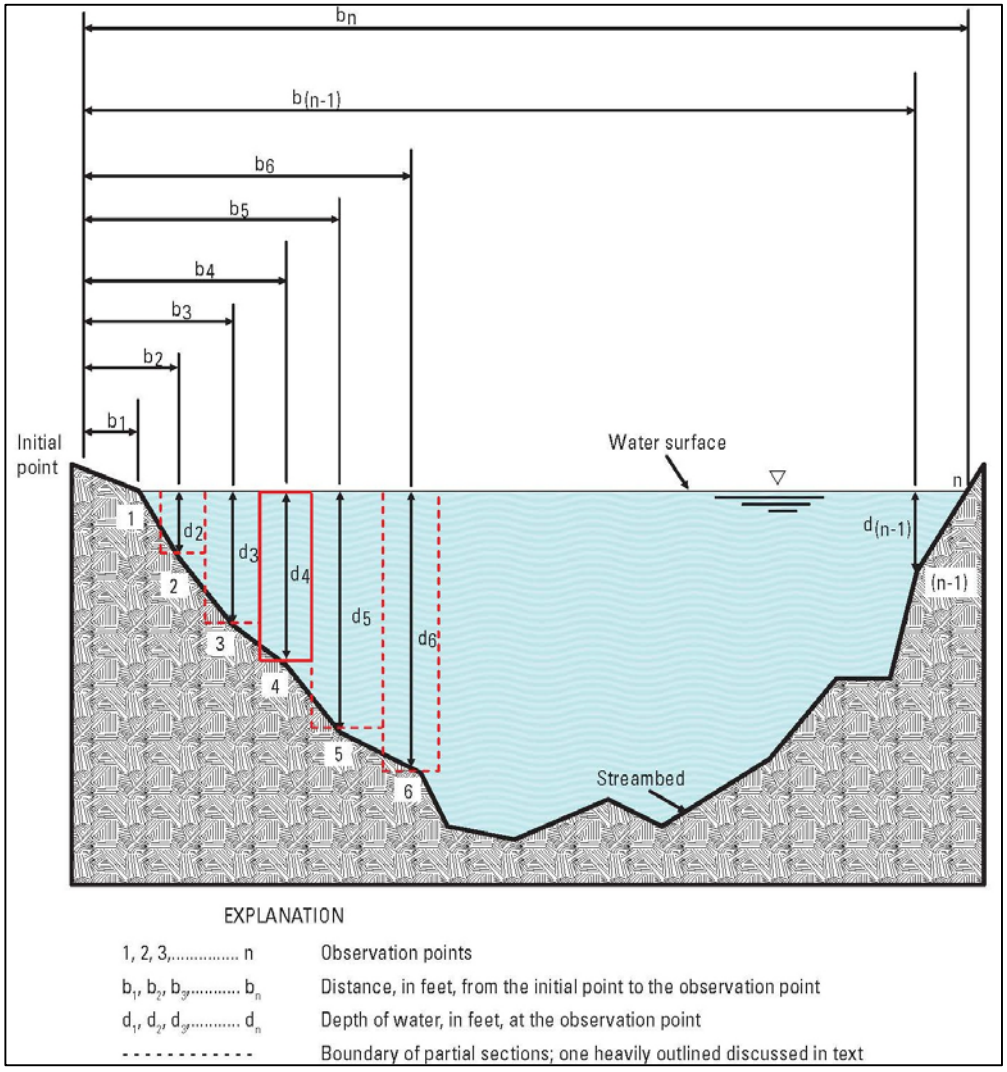
monitoring program that can be sampled routinely moving forward with the program. This should include monthly flow measurements at approximately eight (8) monitoring stations on streams in the mining area, including if possible, the main streams sampled for surface water quality (i.e., Thiapikouré, Pora, Lafou, Boundou Wandé, and Cogon rivers shown in Figure 5). These stations should be accessible for sampling during both the wet and dry seasons. Flow monitoring in the Kamsar area is not recommended due to the strong tidal influences on flow and water level.

A Hach FH950 Portable Flow Meter with an electromagnetic flow sensor has been purchased to obtain the stream flow measurements. The unit delivers real time measurements that can be downloaded directly to a computer and can automatically calculate total discharge based on United States Geological Survey (USGS) or ISO 748 standards for mid-section or mean-section methods.

Discharge refers to the volume of water moving down a stream or river per unit of time (e.g., cubic meters per day, m^3/d) and is generally computed by multiplying the area of water in a channel cross section by the average velocity of water in that cross section (discharge = area x velocity). The most common method used by the USGS for measuring discharge is the mechanical current-meter method where, (a) the stream cross-section is first divided into numerous subsections (rectangles); (b) the area of each subsection is obtained by measuring the width and depth of the subsection (area = width x depth); (c) the water velocity of the subsection is measured with the current meter (flow meter); (d) the discharge of each subsection is calculated (area x velocity); and, (e) the total discharge of the cross section is computed by summing the discharge of all the subsections (see Figure 3). When the mid-section method is applied as shown in Figure 3, the mean velocity (*v*) measured at one or more points along a vertical is assumed to represent the mean velocity of the subsection (rectangle); the cross-section area of the subsection extends laterally from half the distance from the preceding vertical to half the distance to the next vertical (*b*) and vertically from the water surface to the streambed (*d*) (USGS 2010). Thus, for example, the discharge (*q*) through subsection 4 (heavily outlined in Figure 3) is calculated as follows (USGS 2010):

$$q4 = v4 \left[\frac{b5 - b3}{2}\right] d4$$

Figure 3 Definition Sketch of the Current-meter Mid-section Method of Computing Cross-section Area for Discharge Measurements



Source: USGS (2010).

3.2 FIELD MEASUREMENTS

The hand held YSI Pro Plus multi-probe instrument that was purchased during the 2014 field program will be used to obtain in-situ field measurements of pH, temperature, conductivity, dissolved oxygen, and ammonium / ammonia (freshwater only) at all surface water monitoring stations (at both Kamsar and Sangarédi; see Figures 3 and 4) during all sampling events (see Table 1). Standard solutions for pH (pH 4, 7 and 10

buffer solutions), conductivity (12880 µS/cm at 25°C), and ammonia (1 mg/L and 100 mg/L) will be needed to calibrate the unit.

3.3 SURFACE WATER QUALITY

3.3.1 Monitoring Stations

A summary of recommended surface water monitoring locations is provided in Table 1 while the locations are shown in Figure 4 for the Kamsar study area and Figure 5 for the Sangarédi study area. Table 1 includes stations (those with latitude and longitude coordinates) that were previously sampled at Kamsar and Sangarédi during the 2014 field program as well as new stations recommended to capture conditions in eco-sensitive areas occurring within the mining area and to assess the potential impact of the two landfill sites. The official landfill site is located southeast of the Kamsar Port in Bendougou. A second landfill, or makeshift dump site, is located within the mining area along the eastern edge of the Sangarédi township.

3.3.1.1 Kamsar Port Area

The results of the 2014 field program in the Kamsar Port area, which included samples collected along the Dougoufissa River upstream and downstream of the processing facility and into the Rio Nuñez estuary, indicated a strong tidal influence on surface waters which were well mixed in both the river and the estuary. The processing facility was only seen to have an effect on aluminum levels within the Rio Nuñez which increased from the river mouth towards the ship loader further out into the estuary. Spatially, the surface water and sediment stations that were sampled during the 2014 program were sufficient to characterize existing conditions in the port area. It is recommended that stations K-01 to K-10 included in Table 1 and shown in Figure 4 for the Kamsar Port area be sampled during the 2015 field program on a monthly frequency.

As shown in Figure 4, the official landfill is located inland from the Kamsar Port, approximately 8 km to the southeast in Bendougou. The landfill is surrounded by mangrove and is situated north of a large inlet to the Rio Nuñez. Surface water monitoring around the landfill was not conducted in 2014 but is recommended for the 2015 program to determine if the landfill is affecting surface water quality downgradient of the landfill. The establishment of surface water monitoring stations upstream and downstream of the landfill, two (2) in the tributary to the main inlet flowing in a southerly direction parallel to the landfill (L-01 and L-02) and two in the main inlet flowing to the Rio Nuñez (L-03 and L-04) will help assess whether seepage from the landfill is

influencing the local surface water. While tentative monitoring locations are shown in Figure 4, appropriate sites will need to be identified during the initiation phase of the 2015 field program that can also be monitored routinely moving forward with the program.

3.3.1.2 Sangarédi Mining Area

During the 2014 monitoring program, surface water and sediment sampling in the mining area focused on the main streams flowing within the current footprint of the mine in the area east of the watershed divide and into the Cogon River watershed. Streams such as the Thiapikouré (stations SW1 and SW12), Boundou Wandé (SW10), Lafou (SW3 and SW6), and Pora (SW5) flowing eastward towards the Cogon River, as well as the Cogon River (SW7 and SW8), were sampled upstream and downstream of mining activities to identify potential impacts of the activities on surface waters. A couple of other stations were also sampled in areas where mining activities were expected to expand (station SW2 west of the mine area on the Kéwéwol River and SW11 north of the mine area on the Parawol Aliou River) as well as a stream in the Sangarédi stockpile area (SW9).

Since the 2014 field program, a number of eco-sensitive areas with respect to fish, amphibians, crocodiles and land animals have been identified in the Sangarédi study area. As shown in Figure 5, the sensitive areas for land animals such as chimpanzees, occur west of the mining area within the Tinguilinta River watershed. When production ramps up from 18.5 MTPA after 2019, mining activities are expected to expand mostly to the north and west of the current footprint and into or close to many of these eco-sensitive areas. With this in mind, a number of additional new monitoring stations are being recommended for the 2015 surface water and sediment monitoring program to characterize existing conditions within eco-sensitive areas that may be affected by current or future mining activities (18.5 MTPA scenario as well as higher production scenarios). These include Stations SW13 – SW23 included in Table 1 and shown in Figure 5.

The location of Station SW2 that was previously sampled in 2014 has been re-located further downstream along the Kéwéwol River. Station SW9 in the stockpile area and the wells (SW3(1) and SW4) that were sampled in 2014 have been omitted from the 2015 program. The new station in the eco-sensitive area along the Ndousihouri River is located near the dump site occurring in the east end of the Sangarédi township.

Table 1 Recommended Surface Water and Sediment Quality Monitoring Locations and Sample Collections

Station ID	General Location	Comments	Latitude	Longitude	Surface Water			Sediment
					Field Measurements	General Chemistry	Total Metals	Inorganics and Metals
Kamsar Port Area and Landfill								
K-05	Dougoufissa River		10.65580	-14.58168	✓	✓	✓	✓
K-06	Dougoufissa River		10.63923	-14.60413	✓	✓	✓	✓
K-07	Dougoufissa River		10.64482	-14.61550	✓	✓	✓	✓
K-01	Rio Nuñez		10.64367	-14.63643	✓	✓	✓	✓
K-02	Rio Nuñez		10.63505	-14.63797	✓	✓	✓	✓
K-03	Rio Nuñez		10.63790	-14.62943	✓	✓	✓	✓
K-04	Rio Nuñez		10.64210	-14.62620	✓	✓	✓	✓
K-08	Rio Nuñez		10.64693	-14.61477	✓	✓	✓	✓
K-09	Rio Nuñez		10.65013	-14.61875	✓	✓	✓	✓
K-10	Rio Nuñez		10.65188	-14.61770	✓	✓	✓	✓
L-01	Landfill		new station		✓	✓	✓	
L-02	Landfill		new station		✓	✓	✓	
L-03	Landfill		new station		✓	✓	✓	
L-04	Landfill		new station		✓	✓	✓	
Sangarédi Mining Area								
SW1	Thiapikouré River (near Sangarédi)	Cogon watershed	11.09922	-13.81998	✓	✓	✓	✓
SW3	Lafou River (upstream)	Cogon watershed	11.04550	-13.88875	✓	✓	✓	✓

Table 1 Recommended Surface Water and Sediment Quality Monitoring Locations and Sample Collections (Cont'd)

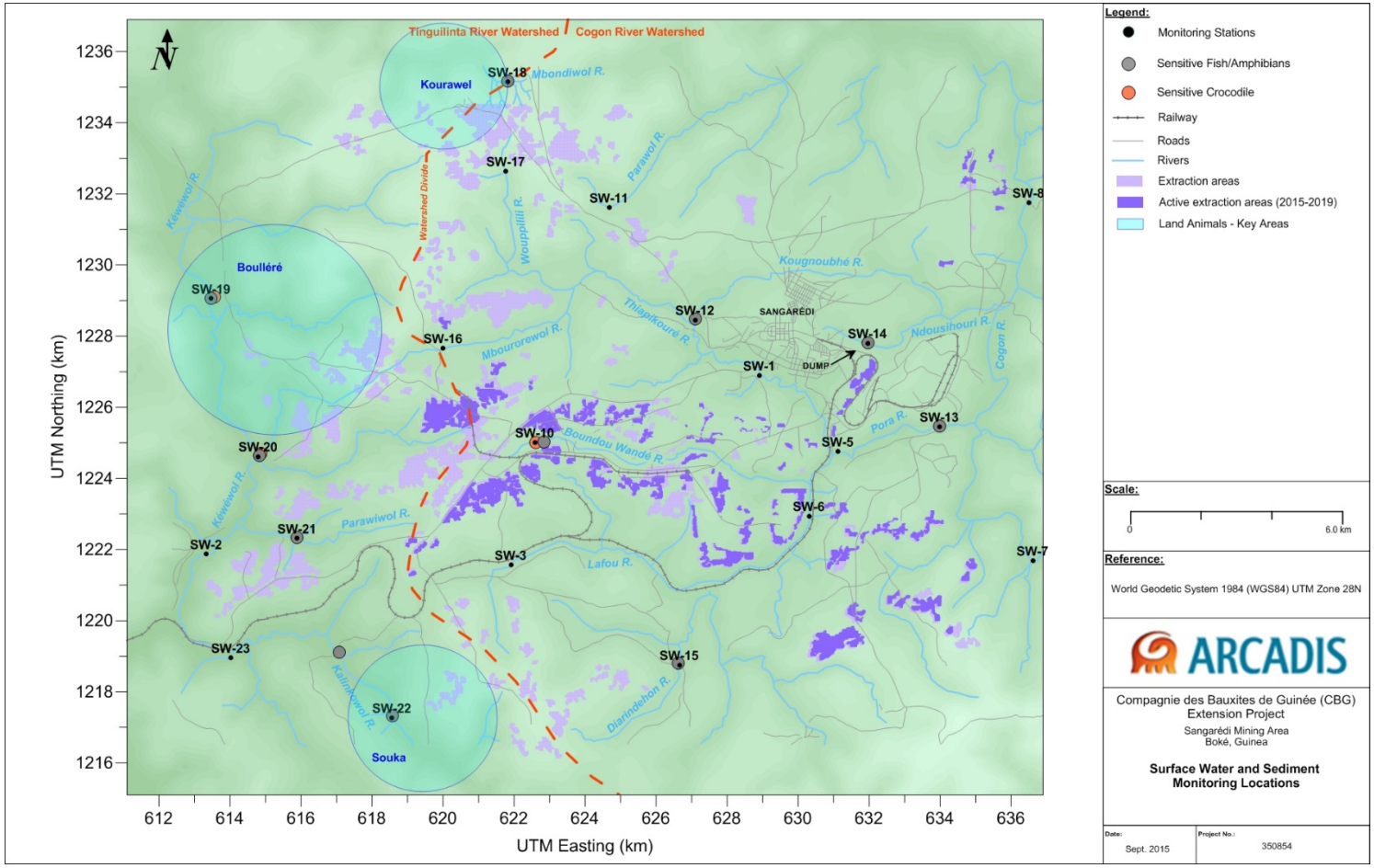
Station ID	General Location	Comments	Latitude	Longitude	Surface Water			Sediment
					Field Measurements	General Chemistry	Total Metals	Inorganics and Metals
SW5	Pora River (upstream)	Cogon watershed	11.07735	-13.80028	✓	✓	✓	✓
SW6	Lafou River (downstream)	Cogon watershed	11.06033	-13.80740	✓	✓	✓	✓
SW7	Cogon River (upstream)	Cogon watershed	11.04668	-13.75113	✓	✓	✓	✓
SW8	Cogon River (downstream)	Cogon watershed	11.14017	-13.75008	✓	✓	✓	✓
SW10	Bondou Wandé River	Cogon watershed; eco-sensitive area	11.07893	-13.87995	✓	✓	✓	✓
SW11	Parawol Aliou River	Cogon watershed	11.14137	-13.86083	✓	✓	✓	✓
SW12	Kougnoubhé River	Cogon watershed; eco-sensitive area	11.11475	-13.83395	✓	✓	✓	✓
SW13	Pora River (downstream)	Cogon watershed; eco-sensitive area	new station		✓	✓	✓	✓
SW14	Ndousihouri River	Cogon watershed; eco-sensitive area near dump	new station		✓	✓	✓	✓
SW15	Diarindehon River	Cogon watershed; eco-sensitive area	new station		✓	✓	✓	✓
SW16	Mbourorewol River	Cogon watershed	new station		✓	✓	✓	✓
SW17	Wouppilili River	Cogon watershed	new station		✓	✓	✓	✓
SW18	Mbondiwol River	Cogon watershed; eco-sensitive area	new station		✓	✓	✓	✓

Table 1 Recommended Surface Water and Sediment Quality Monitoring Locations and Sample Collections (Cont'd)

Station ID	General Location	Comments	Latitude	Longitude	Surface Water			Sediment
					Field Measurements	General Chemistry	Total Metals	Inorganics and Metals
SW19	Kéwéwol River (upstream)	Tinguilinta watershed; eco-sensitive area	new station		✓	✓	✓	✓
SW20	Kéwéwol River	Tinguilinta watershed	new station		✓	✓	✓	✓
SW2	Kéwéwol River (downstream)	Tinguilinta watershed	relocated		✓	✓	✓	✓
SW21	Parawiwol River	Tinguilinta watershed; eco-sensitive area	new station		✓	✓	✓	✓
SW22	Kalinkowol River (upstream)	Tinguilinta watershed; eco-sensitive area	new station		✓	✓	✓	✓
SW23	Kalinkowol River (downstream)	Tinguilinta watershed	new station		✓	✓	✓	✓

Figure 4 2015 Water and Sediment Sampling Locations at Kamsar Port Area

Figure 5 2015 Water and Sediment Sampling Locations at Sangarédi Mining Area



3.3.2 Sampling Methodology

The Wildco Horizontal Beta sampler that was purchased during the 2014 field program will be used to collect surface water samples from all monitoring locations included in Table 1. Subsamples for the measurement of general chemistry parameters (collected in two 500-mL bottles) and total metals (collected in one 120-mL bottle containing preservative acid (2 mL, 18% nitric acid)) will be collected from the Wildco sampler. In addition, approximately 20% of each sample type from each study area will be collected in duplicate where the Wildco sampler is again deployed and subsampled; field and travel blanks of each sample type will also be included in the sample plan. All sampling and sample handling will be conducted wearing latex gloves and all water samples will be stored in zip-lock bags to avoid cross contamination.

It is recommended that surface water sampling is conducted on a monthly frequency, at least for the first year of the program.

3.3.3 Laboratory Analysis

During the initial phase of the field program (September – November 2015), all surface water samples requiring physical and chemical analyses will be shipped from Guinea to an accredited laboratory in Canada (Maxxam Analytics, Mississauga, Ontario). Maxxam typically uses parameter-specific analytical methods based on standard methods developed or approved by the United States Environmental Protection Agency (U.S. EPA) or the Standard Methods Committee (SMC). The parameters that will be analyzed in surface water samples for this program are outlined below in Table 1.

Table 2 Summary of Analytical Parameters for Surface Water Samples

Parameter				
General Chemistry				
Alkalinity				
Chloride (Cl^-)				
Dissolved Organic Carbon (DOC)				
Hardness (calculated as $CaCO_3$); Calcium (Ca) and Magnesium (Mg)				
pH				
Sulphate (SO_4^{2-})				
Total Dissolved Solids (TDS)				
Total Suspended Solids (TSS)				
Total Metals (by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS))				
Aluminum (Al)	Cadmium (Cd)	Lithium (Li)	Selenium (Se)	Titanium (Ti)
Antimony (Sb)	Calcium (Ca)	Magnesium (Mg)	Silver (Ag)	Tungsten (W)
Arsenic (As)	Chromium (Cr)	Manganese (Mn)	Sodium (Na)	Uranium (U)
Barium (Ba)	Cobalt (Co)	Molybdenum (Mo)	Strontium (Sr)	Vanadium (V)
Beryllium (Be)	Copper (Cu)	Nickel (Ni)	Tellurium (Te)	Zinc (Zn)
Bismuth (Bi)	Iron (Fe)	Potassium (K)	Thallium (Tl)	Zirconium (Zr)
Boron (B)	Lead (Pb)	Silicon (Si)	Tin (Sn)	

3.4 SEDIMENT QUALITY

3.4.1 Monitoring Stations

Sediment samples in both the Kamsar and Sangarédi study areas will be collected from the same locations as surface water samples (with the exception of the landfill sites L01 - L04). See Section 3.3.1 and Table 1 for details.

3.4.2 Sampling Methodology

The Wildco 6x6" Petite Ponar sediment sampler that was purchased during the 2014 field program will be used to collect sediment samples from all monitoring locations included in Table 1 except stations L01 – L04). At each station, three separate grab samples will be collected and sub-samples from all three will be composited into a single sample that will be sent to the laboratory for analysis. This approach will help capture the inherent variability (heterogeneity) within the sediments. Approximately

20% of all samples collected at each study area will be collected in duplicate where the Petite Ponar is again deployed and sub-sampled three times.

The composite samples will be collected into 120 mL glass jars with Teflon lined lids and will be analyzed for metals, moisture content, total organic carbon (TOC) and grain size. Once collected, sediment samples will be packed individually into zip-lock bags to avoid cross contamination. All sampling and sample handling will be conducted wearing latex gloves to minimize the potential for contamination.

It is recommended that sediment sampling is conducted on a monthly frequency, at least for the first year of the program.

3.4.3 Laboratory Analysis

During the initial phase of the field program (September – November 2015), all sediment samples requiring physical and chemical analyses will be shipped from Guinea to an accredited laboratory in Canada (Maxxam Analytics, Mississauga, Ontario). Maxxam typically uses parameter-specific analytical methods based on standard methods developed or approved by the U.S. EPA or SMC. The parameters that will analyzed in sediment samples for this program are outlined below in Table 3.

Table 3 Summary of Analytical Parameters for Sediment Samples

Parameter				
Moisture				
Total Organic Carbon (TOC)				
Total Metals (Strong Acid Leachable Metals by ICP-MS)				
Aluminum (Al)	Cadmium (Cd)	Lithium (Li)	Potassium (K)	Titanium (Ti)
Antimony (Sb)	Calcium (Ca)	Magnesium (Mg)	Selenium (Se)	Uranium (U)
Arsenic (As)	Chromium (Cr)	Manganese (Mn)	Silver (Ag)	Vanadium (V)
Barium (Ba)	Cobalt (Co)	Molybdenum (Mo)	Sodium (Na)	Zinc (Zn)
Beryllium (Be)	Copper (Cu)	Mercury (Hg)	Strontium (Sr)	
Bismuth (Bi)	Iron (Fe)	Nickel (Ni)	Thallium (Tl)	
Boron (B)	Lead (Pb)	Phosphorous (P)	Tin (Sn)	

4. SUMMARY OF RECOMMENDATIONS

- It is recommended that for the first year of the field program (September 2015 to 2016), monitoring for surface water (flow and field measurements and quality) and sediment be completed at a monthly frequency to capture seasonal variations that will provide a more accurate characterization of existing conditions within each study area (Kamsar and Sangarédi).
- A number of additional new monitoring stations are being recommended for the 2015 surface water and sediment monitoring program to characterize existing conditions within eco-sensitive areas that may be affected by current or future mining activities; surface water monitoring is also recommended around the official landfill site near Kamsar and the dump in Sangarédi.
- *During the initial phase of the program, CBG will need to identify a laboratory to provide ongoing support for chemical analysis moving forward with the monitoring program; CBG will also need to assume the responsibility of ordering and obtaining sampling supplies from the laboratory and shipping samples to the laboratory for analysis.*

5. REFERENCES

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APPENDICES

Appendix 9.3 Summary dredging and sediment disposal plan

Summary dredging and sediment disposal plan

July 2015

Compagnie des Bauxites
de Guinée

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1 INTRODUCTION

CBG is a mining company belonging jointly to the Government of Guinea and Halco Mining (Alcoa, Rio Tinto Alcan and Dadco). Currently CBG extracts bauxite from its mine at Sangaredi in northwestern Guinea and transports it by a railway to its facilities (plant and mineral port) at Kamsar. CBG has been in existence since 1963 and its installations have been in operation since 1973.

Within the context of the Expansion Project, dredging work is planned in the area of the CBG jetty and the turning basin. This work is the object of a contractual package and will be carried out by the selected company (EPC) under the supervision of the EPCM company. This plan describes in a summary fashion the work to be carried out, the preparatory work and studies, the area to be dredged and the area selected for the disposal of the dredged sediments.

This plan should be an indispensible tool to the Project goal of obtaining the environmental authorizations needed to start the work. This document contains the summary plan of the dredging work and the disposal of approximately 300,000 m^3 of sediments.

2 SCOPE OF WORK

During the FEL2 study phase, Royal Haskoning was mandated to conduct a pre-feasibility study for a new port structure suitable for the increase in production by CBG. This study had as a goal the development of a development plan for the marine operations. The scenario retained at the end of this study generated a dredging volume of approximately 402,000 m^3, at the end of the three phases of the Project with a production rate of 27.5 MTPA.

Transition to the FEL3 feasibility study was approved with a production rate of 18.5 MTPA (Phase I). The dredging work is justified by the extension of the existing jetty and the increase in marine traffic.

At the beginning of FEL3 a bathymetric study was undertaken. The results of the study validated a dredging volume of approximately 300,000 m3 for carrying out Phase I of the Project (Figure 1).

The techniques and work methods will be detailed when the contract will have been awarded.

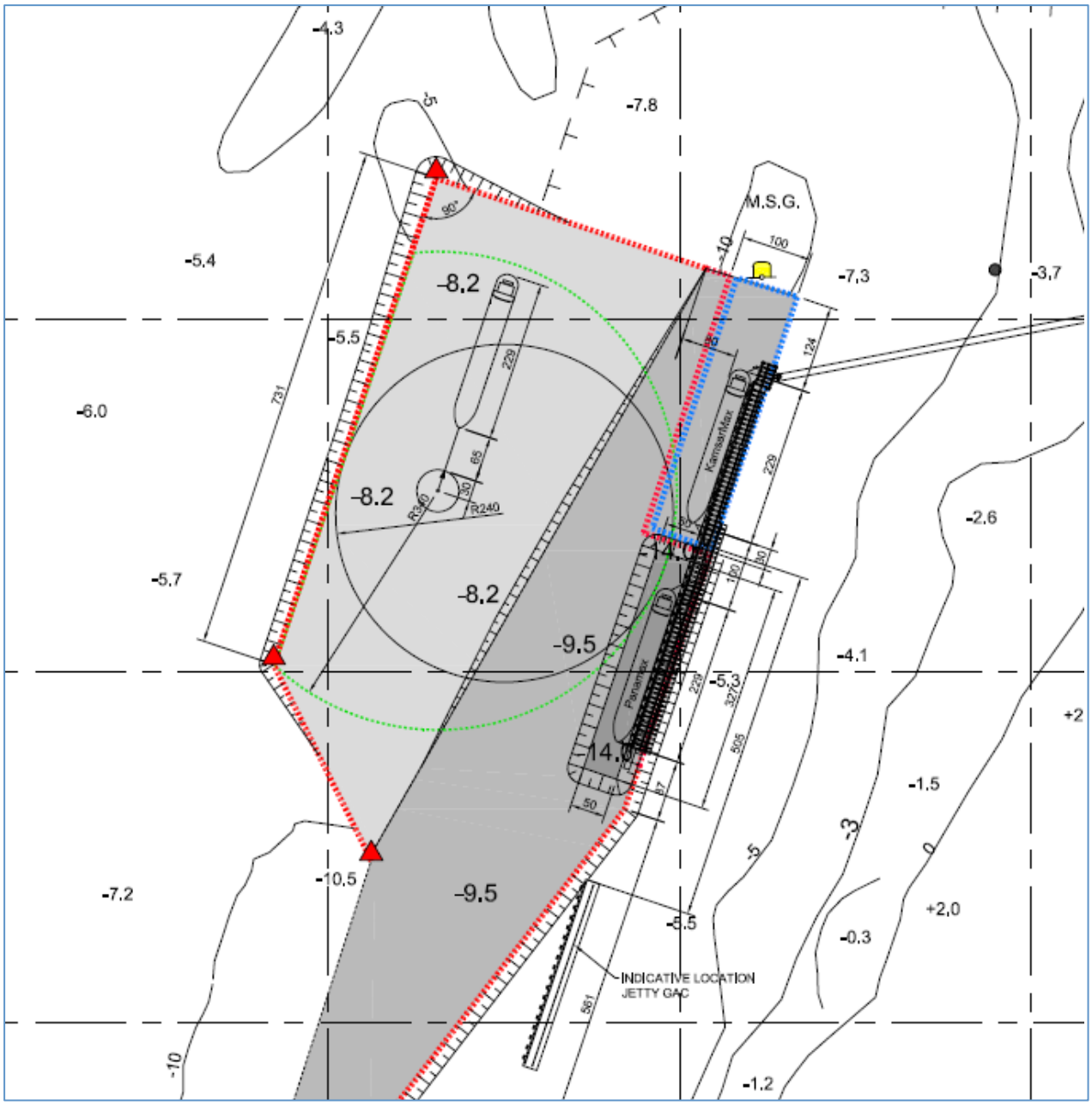


Figure 1 **Dredging area for Phase I of the Project (18.5 MTPA)**

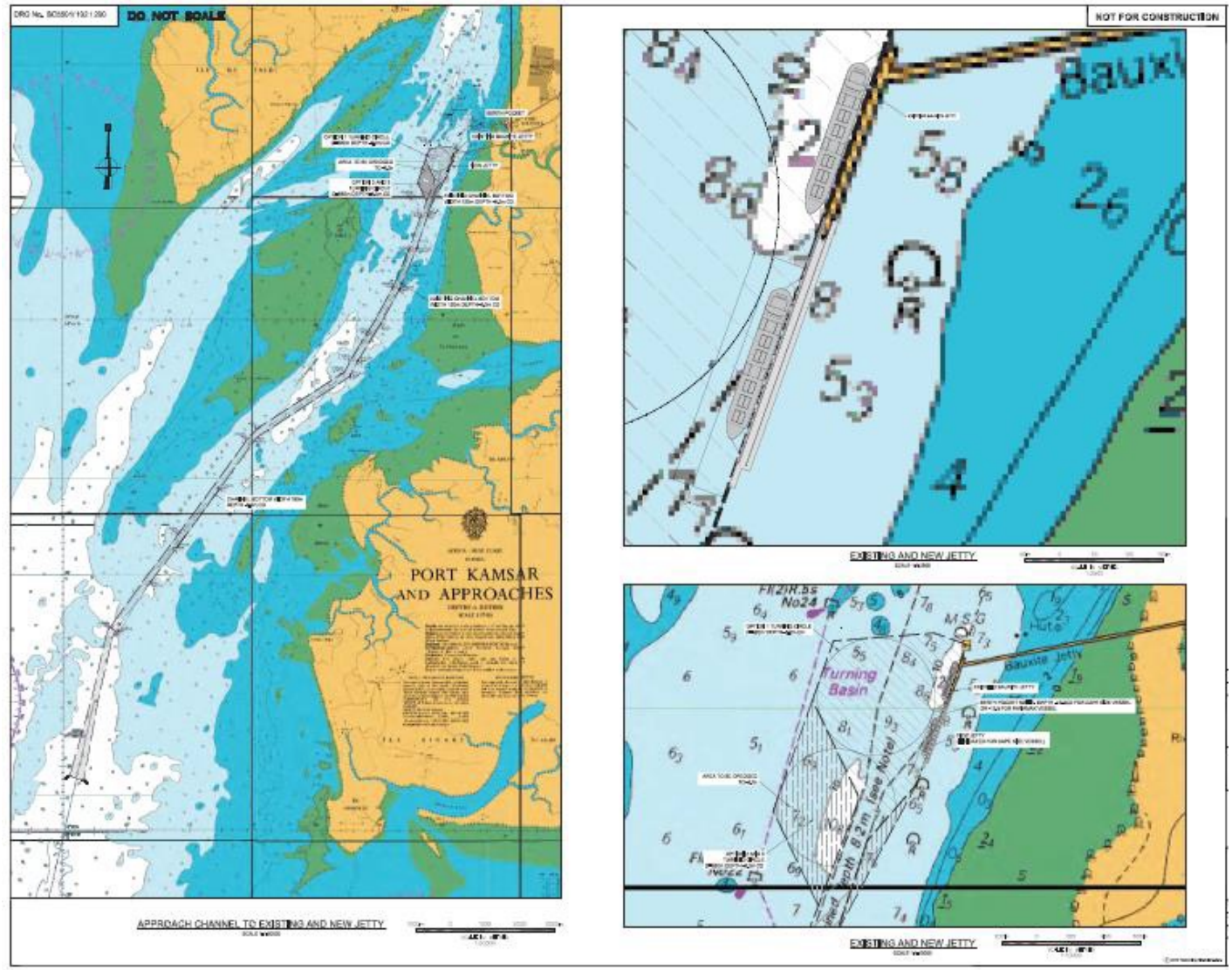


Figure 2 Location of the CBG Kamsar port and the dredging area

3 SEDIMENT DISPOSAL AREA

The dredging will take place in the Rio Nuñez estuary. Because of the shallowness in this section and the presence of currents and the tidal effects, it was not possible to identify an area allowing the disposal of sediments close by. Within the context of the Expansion Project, use of the sediments for land-based construction work was not a valued-added item.

The Project team therefore studied the possibility of a disposal site at sea, as close as possible to the work site. After validation, the most suitable area would be an area at the entry to the estuary. This area has already been used for the disposal of sediments dredged during the regular maintenance of the access channel. This location, to the west of the entrance to the access channel, is also outside of the critical habitat area determined during the ESIA and outside of the local fishing corridor.

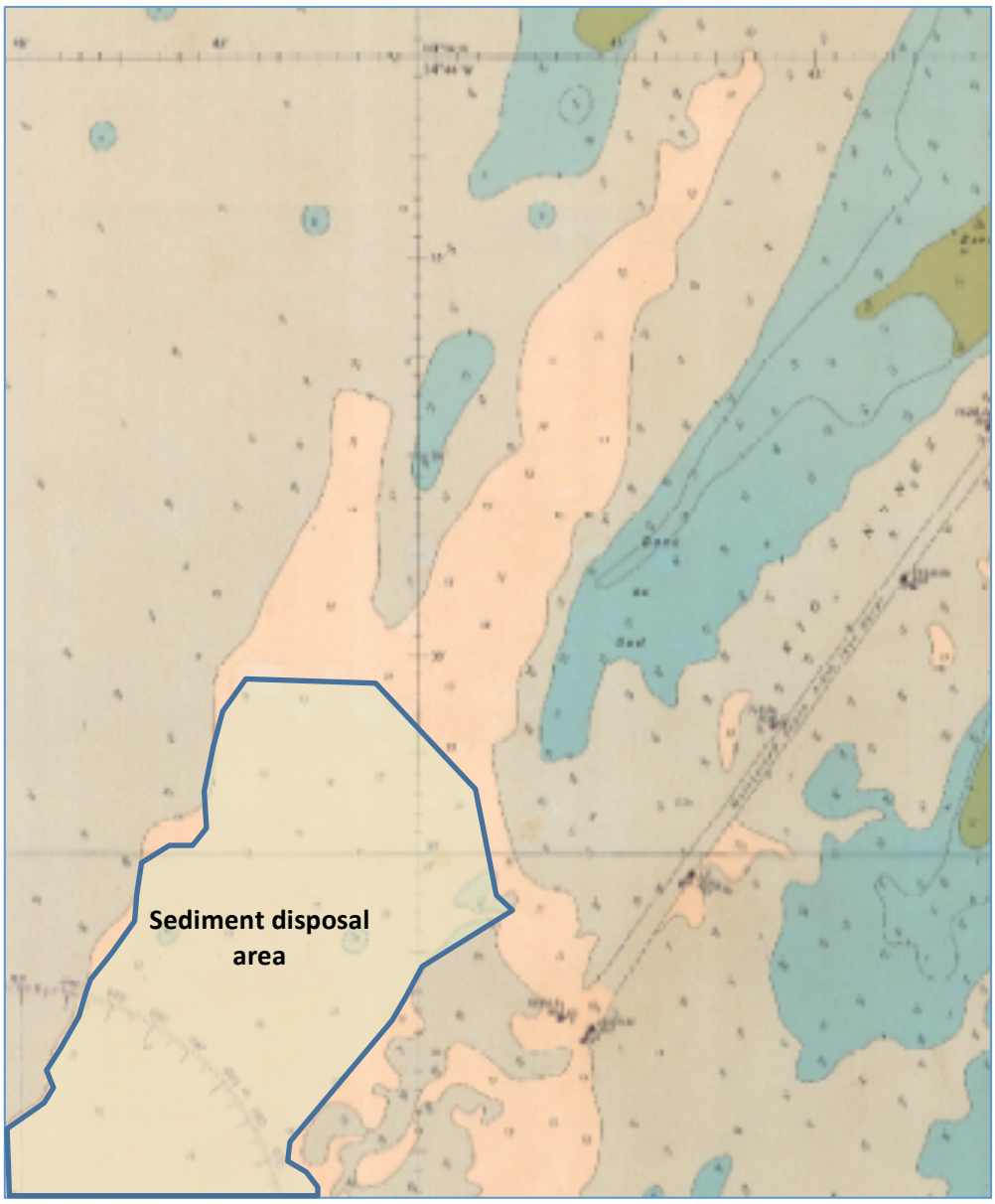


Figure 3 Sediment disposal area

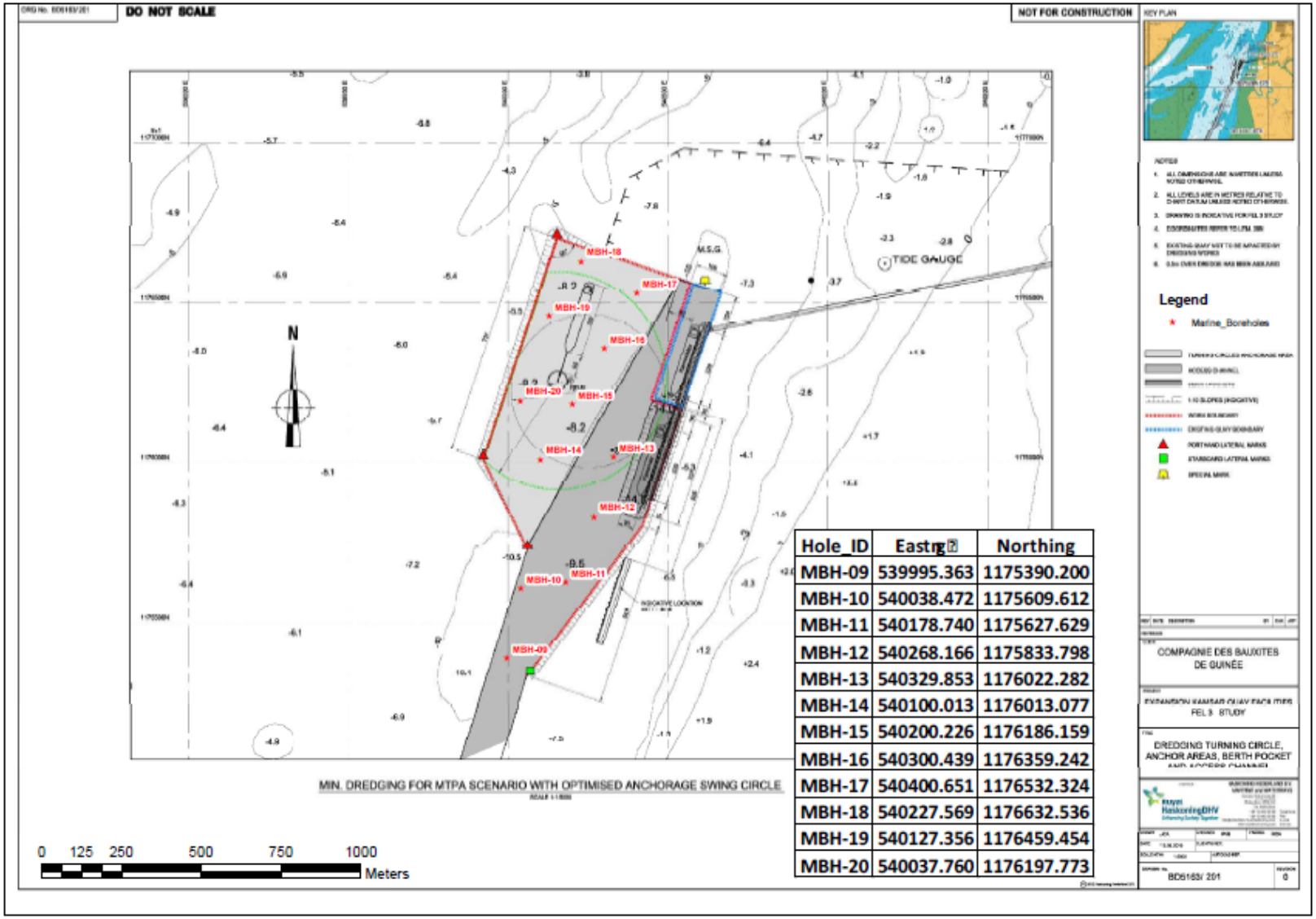
4 PREREQUISITE STUDIES

During the ESIA of the Expansion Project, it was mentioned that additional studies would have to be undertaken before going ahead with the dredging operations:

- Benthic fauna study
- Physical and chemical characterization of the sediments of the dredger area

These two studies will be carried out during the marine geotechnical studies. The Geocontrole Company was mandated to do the sampling needed to characterize the sediment samples. CBG will ensure the taking of additional samples to characterize the benthic fauna. Twelve sampling points were identified where composite samples will be taken. The sampling and analysis methods were determined taking as reference the *Revised OSPAR Guidelines for the Management of Dredged Material.*

An application for an environmental authorization will be submitted to the Guinean authorities only after receiving the study results.



Hole_ID	Easting	Northing
MBH-09	539995.363	1175390.200
MBH-10	540038.472	1175609.612
MBH-11	540178.740	1175627.629
MBH-12	540268.166	1175833.798
MBH-13	540329.853	1176022.282
MBH-14	540100.013	1176013.077
MBH-15	540200.226	1176186.159
MBH-16	540300.439	1176359.242
MBH-17	540400.651	1176532.324
MBH-18	540227.569	1176632.536
MBH-19	540127.356	1176459.454
MBH-20	540037.760	1176197.773

Figure 4 Sediment and benthos sampling points

5 ENVIRONMENTAL RECOMMENDATIONS

Recommendations were brought up in the context of the ESIA. These recommendations, which also appear in the ESMP, were integrated into the request for proposal process for the carrying out of the work or to the calendar for the carrying out of the work

I. The Project will put in place mitigation measures to protect important biological species in the Rio Nuñez estuary (ESIA, Volume C, Annexe 3-2, Page 63-65):
    a. Avoid the use of sucking dredges during the dredging. If there are no alternatives, turtle shields or other protection must be used;
    b. Reduce underwater noise as much as possible during dredging or jetty construction;
    c. Impose in the estuary a speed limit of 18.5 km/hr. for all ships, associated with a 11 km/hr. limit when less than 100m from the coast;
    d. Recommend that ships maintain a constant direction without zigzagging as much as possible;
    e. Avoid using ships or boats without propeller protectors (cowlings) during the work.
II. So as to reduce impacts predicted in the ESIA as much as possible, the Project will avoid dredging work between the months of August and January. This is to apply where feasible in the context of the overall Project schedule.

6 CONCLUSION

This plan is meant to be a summary-level tool to ensure good environmental management of the dredging required in the context of the Expansion Project. This document contains a summary plan of the dredging activities and the disposal of approximately 300,000 m^3 of sediment. The detailed plan will be finalized in collaboration with the company retained to carry out the work. This plan will detail working methods, equipment to be used and mitigation measures. The plan will also contain security measures to be put in place during the dredging work and to ensure safe navigation in the port area.

APPENDICES

Appendix 9.4 Groundwater sampling plan

ARCADIS

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Progress Report

To:
Eric Muller - EEM

Copies:
Jennifer Kirkaldy - ARCADIS

Our Ref.:
350854

Date:
September 14, 2015

From:
Craig Kelly

Subject:
Final – Proposed Monitoring Well Network and Monitoring Program – CBG Guinea 2015 to 2019, Kamsar Port, Sangaredi and Kamsar Landfills

---

One of the recommendations that arose out of the Review Panel deliberations concerning the Environmental Impact Assessment for the proposed CBG Bauxite Mine expansion was the requirement to implement a groundwater monitoring network and monitoring program as a component of the overall environmental monitoring program for the current and future mine operations.

Subsequent discussions with CBG and their consultants indicated that this network should include; current and proposed mining areas for the period 2015 to 2019, the Kamsar Port Area, the Sangaredi Landfill, and the Kamsar landfill. Both of these landfills accept waste from CBG operations. At present, there is no monitoring network for the mine workings or the landfills.

Mining Area Network

The decision to implement the monitoring program for the 2015-2019 mining areas is a type of adaptive monitoring approach. Mining areas have been delineated out to 2038. At present, there really is no baseline data for groundwater in the vicinity of past, present or future mining areas. It is proposed to instrument in the vicinity of past (extracted) areas, and current to future mining areas to 2019. The initial groundwater level and quality data, will, per force, constitute the baseline data for a regional network for the CBG mining areas. Data will be obtained for water resources where extraction has completed, where it is on-going, and where it has not yet begun. This should allow for CBG to use the data from, for instance, a couple of years of quarterly monitoring, to define the extent and intensity of future monitoring.

Eventually, the network can evolve with the movement of operations, both spatially and temporally. In 2019, the results of the monitoring can be used to develop the network and monitoring program for the future 2020-2038 operations, and the network can evolve incrementally.

Based on the scale (areal extent) of the past, current, and proposed mining operations, it was agreed that approximately 25 wells would probably be sufficient to monitor potential effects of the mining operations on groundwater quality. ARCADIS propose that several of the wells be installed near plateau areas that have already be extracted, and that two "background" monitoring locations be established.

A plan of the 2017 to 2019 mining areas has been used to spot potential locations for a groundwater monitoring network, and is attached to this memo. The locations also take into account the 2015-2016 mining areas.

Initially, it was thought that, ideally, monitoring wells would be installed in the lowlands, immediately adjacent to the plateaus, because the water table is known to be below the vertical mining extents in the plateaus, and drilling from the plateau areas increases the amount of drilling required to reach the water table. It has been made apparent to us that there may be a perched aquifer within the plateaus (see below). Where possible, the potential locations are spotted in lowlands, near roads. However, in some instances, based on the information available to us, several locations have been spotted on the plateaus, near mining areas. Knowledge of the field conditions and operations will ultimately guide the final location of some of the wells, in consideration of protecting the wells from vehicular traffic, instrumenting the pertinent aquifer(s), etc., and ease of access to the locations.

The attached mining area plan proposes 26 mining area monitoring locations, including two proposed background wells (see attached Figure). Where feasible, monitoring wells are located in close proximity to proposed surface water monitoring stations (e.g. MW9/SW-6; MW20/SW10; MW3/SW8).

Based on the results of other investigations in the general mining region, it appears that groundwater can be found in two major zones across the mining region. There is an upper, surface aquifer located in the overburden (at the base of the bauxite deposits) on the plateaus, and in alluvial deposits in the river valleys. Traditional wells are hand dug into the water-bearing formations in this zone. Below this, there is a deep groundwater aquifer that is located in the bedrock in the fractured contact zones between the lightly metamorphosed sedimentary (Paleozoic) and intrusive (Mesozoic) rocks.

It should be recognized that the aquifer located in the overburden, at the base of the bauxite deposits on the plateaus, and in alluvial deposits in the river valleys, may be two zones. The plateau zone may be "perched" in the plateaus, topographically above the lower alluvial deposits.

In order to resolve this in the CBG areas, it is proposed that initial drilling be undertaken through a couple of plateaus that have been mined out and, and if the perched water is encountered, above the elevation of the surrounding lowlands, install a well in this perched, zone, and then install a second well in the next aquifer encountered, presumably the shallow “alluvial deposit” aquifer. This two-well location is commonly referred to as a “well nest”. It is recommended that the wells be installed in separate, adjacent boreholes.

If the “perched” plateau water is at the same elevation as the lowland alluvial deposits, only one well will be required (in this case, they are, essentially, the same zone).

The attached figure show six locations where drilling can be initiated to test the shallow aquifer(s) hypothesis. Initially, the borehole should be advanced through the plateau into the lowland elevations. The presence of the perched aquifer can be confirmed, as well as its relationship with the lowland aquifer. A decision can then be made in the field on whether one or two wells will be required. Based on this, up to 32 wells may be installed to comprise the initial 2015-2019 monitoring network, as per the attached Figure.

It should be noted that, if it is found during the initial stage of drilling that the plateau aquifer is distinct from the “alluvial lowland” aquifer, then some thought will have to be given to how to distribute the network, without having to drill a “nest” at every plateau location. It should be established which “aquifer” is used more prevalently as a potable resource. The network as envisioned herein will have to be re-visited. This can be accomplished during the field program.

Kamsar Port

At present, it is proposed to install up to eight monitoring wells in the Kamsar Port Area, downgradient, inferred cross-gradient, and downgradient of the core of the Off-loading Operations Area. The number of wells to newly install could be reduced, should some of the previous Golder monitoring wells still be present and in good condition. A plan has been provided with some potential locations for the Port-area monitoring wells.

Sangaredi Landfill

For the Sangaredi area landfill, it is proposed that five monitoring wells be installed around the landfill footprint, with one at a presumed “background” (upgradient) location.

Kamsar Landfill

At the Kamsar landfill, based on the observed size of the currently used landfill area footprint, it is recommended that eight monitoring wells be installed, three on the presumed downgradient (east) side between the landfill and the mangrove swamp, two on the south side, which also may be downgradient of a portion of the landfill area, due to the influence of the river, with the other three located along the other three sides of the rectangular-shaped footprint. A figure of the Kamsar landfill location is attached, along with a figure of the landfill footprint and approximate potential monitoring well locations.

It is our understanding that there may be one monitoring well at the Kamsar landfill. This well should be located and inspected during the field program. Based on its location and condition, a decision can be made whether it is suitable for use in the monitoring program, and whether it can replace one of the wells proposed above.

Well Construction

The wells should be constructed of 1-1/2 inch to 2 inch diameter PVC riser pipe and slotted well screens. If machine-slotted well screen is available, this should be used. If not, the PVC pipe can be manually slotted with a hacksaw. Well screens should be 1.5 to 3.1 m long, and designed so that the slotted screen straddles the water table surface. Ideally, a lockable steel protective casing should be fitted over the well "stick-up" above ground surface, especially if there is some concern for potential vandalism.

Monitoring of the well locations should be done on a quarterly basis. Guinea resides within a climate regime of "dry season/wet season". The dry season extends from November/December to April, with the wet season encompassing May to October. Based on this, the periods of monitoring should correspond to May, August, November and February-March of a given calendar year.

It is proposed that the analytes for the groundwater monitoring include the following parameters:

- Metals (ICP-MS);
- Petroleum hydrocarbons (PHCs) and BTEX compounds;
- Chloride, sulphate, and alkalinity;
- Dissolved organic carbon,
- Conductivity, pH, and total dissolved solids (TDS).

Based on the monitoring network outlined above, comprising 53 monitoring wells amongst the four areas of interest, and allowing for procuring blind duplicates equivalent to 10 per cent of the total number of

monitoring points, a single round of groundwater monitoring will include 59 samples for groundwater quality analysis.

Proposed well installation and sampling procedures are attached to this memo as Appendix A.

We trust this is sufficient for your current requirements. Should you have any questions, please contact Mr. Craig Kelly of ARCADIS at 905-882-5984 x 435.

ARCADIS

Appendix A

Well Installation and Sampling Procedures

A.1 GROUNDWATER MONITORING

A.1.1 WELL INSTALLATION

Monitoring wells are typically completed using 37.5 or 55 mm (1-1/2 inch to 2 inch) diameter Schedule 40 PVC riser pipes with a 1.5 or 3 m long No. 10 slot intake zone (well screen). In this case, it is not known whether slotted PVC screens will be readily available. If not, the well screen can be constructed by hand-slotting a length of the PVC pipe with a hacksaw. No glues or solvents are used in the construction of the wells to avoid introducing volatiles into the well and, thereby, biasing the analytical results. Silica sand is placed around and to a height of at least 300 mm above the top of the well screen as a gravel pack. The remaining annular is sealed with Holeplug, BenSeal, or other bentonite seal. A protective above-ground steel casing steel casing is then grouted in place at the top of the well to protect the installation from damage or vandalism. In areas where active operations are occurring, protective bollards should be installed around the monitoring well, and be painted a highly visible colour. All elevated casings should be locked. Where wells are to penetrate through low permeability confining strata separating an upper and lower aquifer, a lower seal is set in the confining layer to ensure against the transmission and possible migration of contaminants between aquifers.

A.1.2 GROUNDWATER MEASUREMENT

A dedicated WaTerra-type inertial pump is installed in each well to ensure that samples representative of subsurface water conditions at the location at which the screen is set are recovered without the threat of cross-contamination. Following completion of drilling, the depth from ground surface (borehole collar) to the water table (or potentiometric) surface is measured with the use of a water level indicator and recorded on the borehole log. The wells are developed by hand-pumping the WaTerra sampler to ensure that at least three and as many as ten well volumes of water (depending on recovery periods) are removed to reduce the potential effects of contamination introduced through drilling, and to maximize the responsiveness to the surrounding geological materials.

Water quality parameters including pH, specific conductance, dissolved oxygen, ammonia, and temperature are measured and recorded for each well volume purged during development using the filed parameter equipment that was supplied for use during surface water monitoring.

Following development, the water table or potentiometric surface is allowed to reinstate itself (“recover”) to static water level, prior to obtaining final groundwater elevations. Measurements of the water levels are made from all wells within the same time period to ensure that the results are representative of conditions across the entire site. Any unusual weather conditions and modifying features encountered are noted on the filed log. At some point after installation, the ground and top-of-pipe elevations will be surveyed and referenced to geodetic elevations. Field water level data are reduced with reference to the top of pipe and ground surface elevations and are tabulated with the date of the measurements.

A.1.3 GROUNDWATER SAMPLING

Groundwater samples are recovered from the well through the inertial pump or with a dedicated bailer directly into sterile glass or plastic sample jars that have been pre-treated with preservatives, where appropriate. Sample jars are obtained directly from the laboratory and are received, stored and, when filled, shipped back to the laboratory for analysis in a sealed insulated cooler box. For analyses of inorganic species (metals, anions, cations), the sample is pumped from the well through a 0.45 Fm cartridge filter to eliminate suspended solids. Samples for organic analyses are obtained unfiltered. In both cases, the samples are retained in a marked sample jar to which a sample label identifying the well number, date of sampling and other pertinent information is affixed. The sample labels should be covered with clear plastic tape after marking up, to prevent labels from falling off of the bottles during shipping. The sample jars are filled to the brim to eliminate headspace air to reduce the possibility of oxidation and degassing. Sample bottles are then stored in the insulated cooler and should be cooled with freezer packs to an optimum temperature of less than 8ºC during warm weather pending shipment to the laboratory. Due to the length of time to ship the coolers from Guinea to the laboratory, the freezer packs should be replaced with ice immediately prior to shipping.

A.2 QUALITY ASSURANCE / QUALITY CONTROL

The principal reason for the recovery of soil and groundwater samples in the field is to permit their inspection and analysis to determine whether contaminants or foreign matter is present at levels that constitute a health-, environmental- or construction-related liability, the discharge of which will require remedial or mitigative action. The accuracy with which the analytical results returned from chemical testing at the laboratory reflects the in-place condition is critical to the success of the site characterization program and thus every effort must be taken to ensure that the samples are recovered, handled, stored, shipped to and received at the laboratory in a condition that is representative of the material on site.

A.2.1 SAMPLE PRESERVATION

Preservation requirements for groundwater samples are dependent on the contaminant parameters for which the analyses are being conducted. These requirements will be provided by the laboratory, and, in general, the laboratory will provide sample containers with preservative already inside the containers. Sample hold times are also prescribed by the laboratory. The most sensitive parameters with respect to hold times are volatile organic compounds (including petroleum hydrocarbons/BTEX compounds), which are generally stated to be 14 days from the time of sampling, when preserved.

A.2.2 CHAIN-OF-CUSTODY

Full chain-of-custody procedures are applied from the point at which field staff surrenders responsibility for the samples in the field or, where that individual is responsible for transit from the field location to the office, at their place of work. Chain-of-custody forms, which log the date of transfer and identity of the parties by and to whom the transfer has been made, also record the identity of the samples included in the shipment, the date sampled and sample location, the analyses requested for each sample, the name and address of the laboratory to which the samples are assigned, and any clarifying notes that may be required.

A.2.3 SAMPLE QUALITY MANAGEMENT

Laboratory or field control checks are utilized to ensure that the quality of the analytical data is maintained at an acceptable level. All laboratories to which samples are sent for chemical analysis are CALA-certified and participate in applicable inter-laboratory testing rounds administered by provincial and federal agencies.

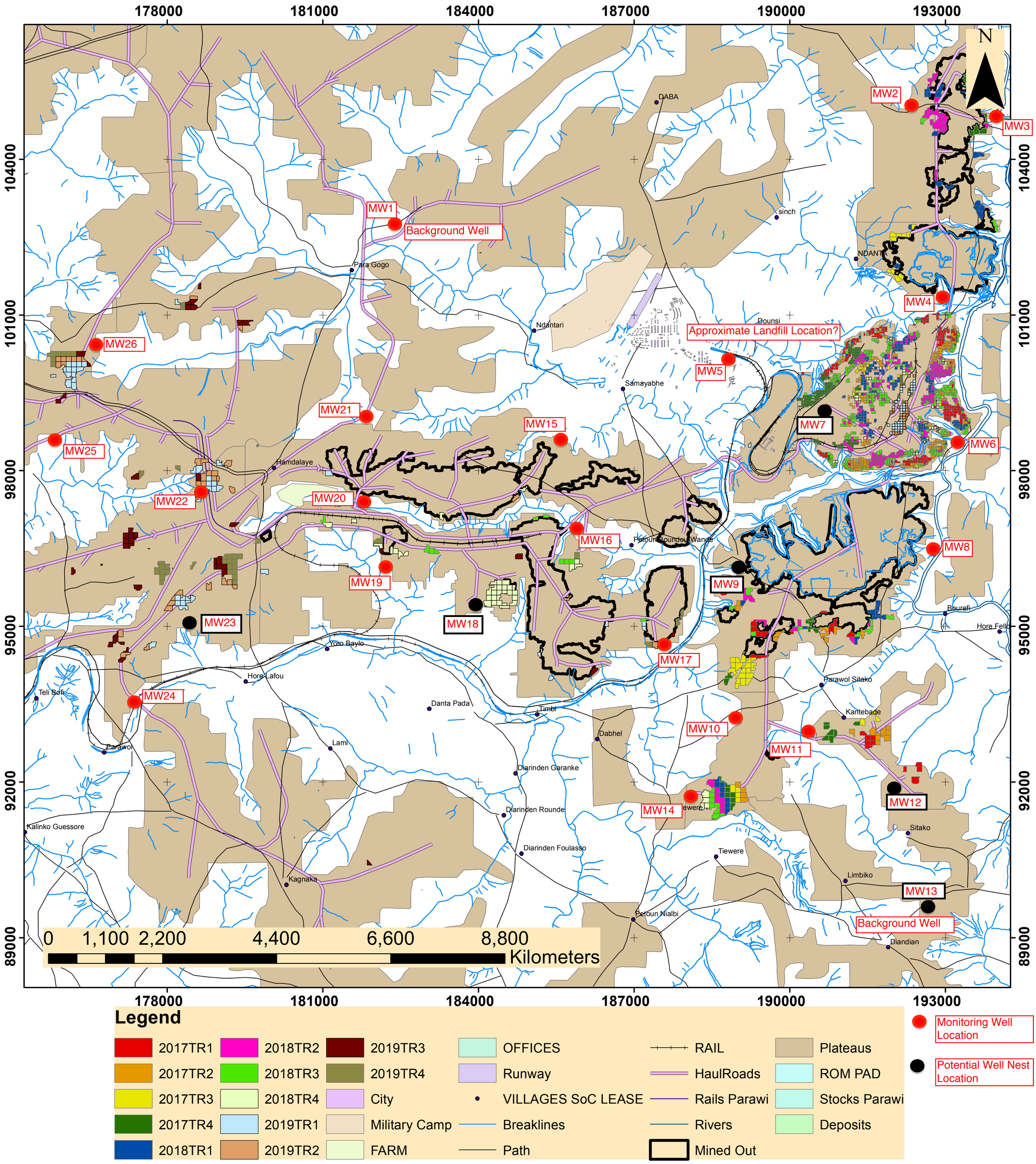
Field duplicate samples, where used, are prepared by obtaining a soil or groundwater sample split from preselected sample locations. The splits are provided with fictitious sample identification designations and submitted to the laboratory for analysis to permit a determination of the internal quality control and repeatability of analyses from the selected laboratory to be determined.

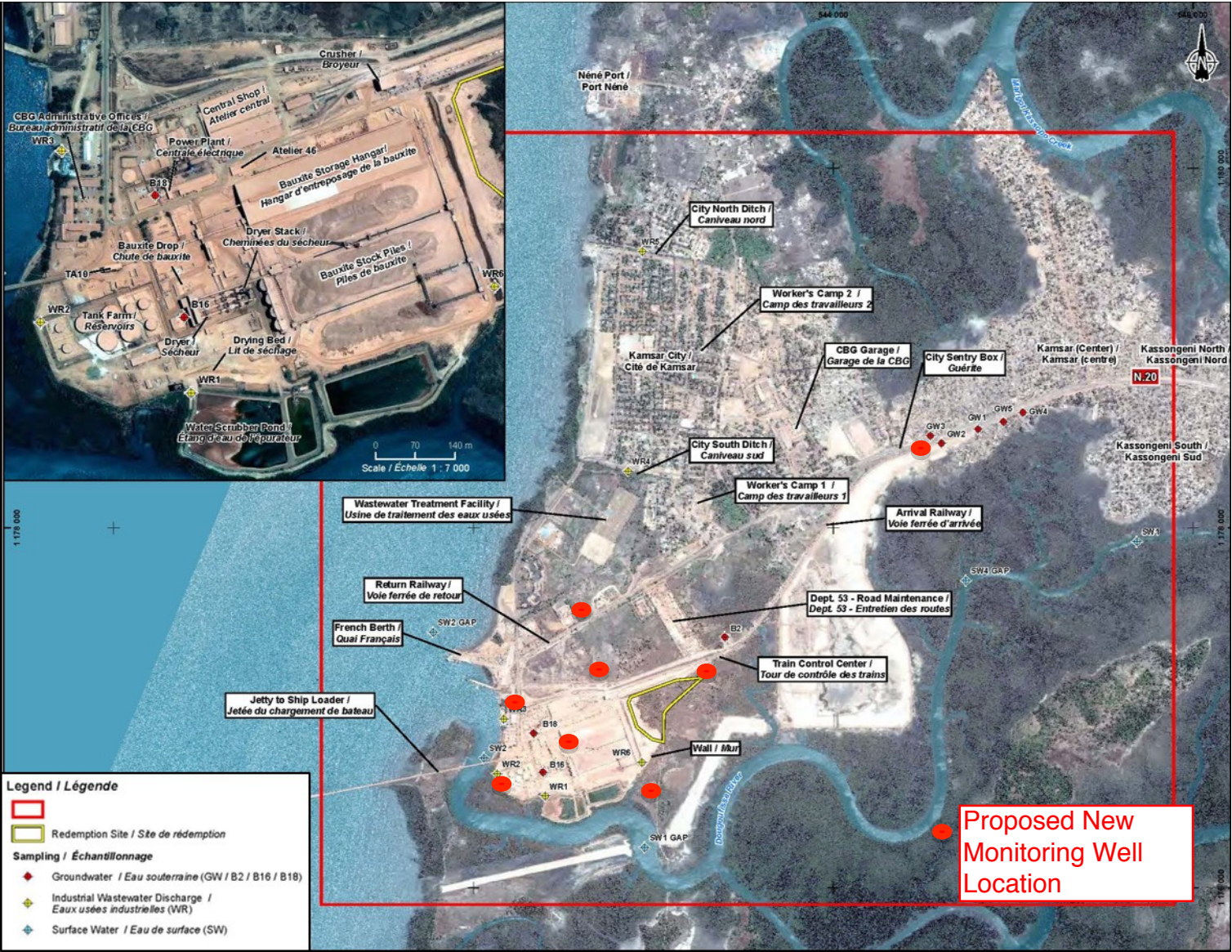
Trip blanks comprising de-ionized water may be prepared by the contracted laboratory to accompany groundwater sample containers to determine whether contamination of the containers or of the samples has occurred during shipment to the field or, following recovery, during storage and shipment from the field to the laboratory. Trip blanks are generally enclosed with sample sets recovered for analysis for the presence of volatile organic compounds (including petroleum hydrocarbons/BTEX compounds).

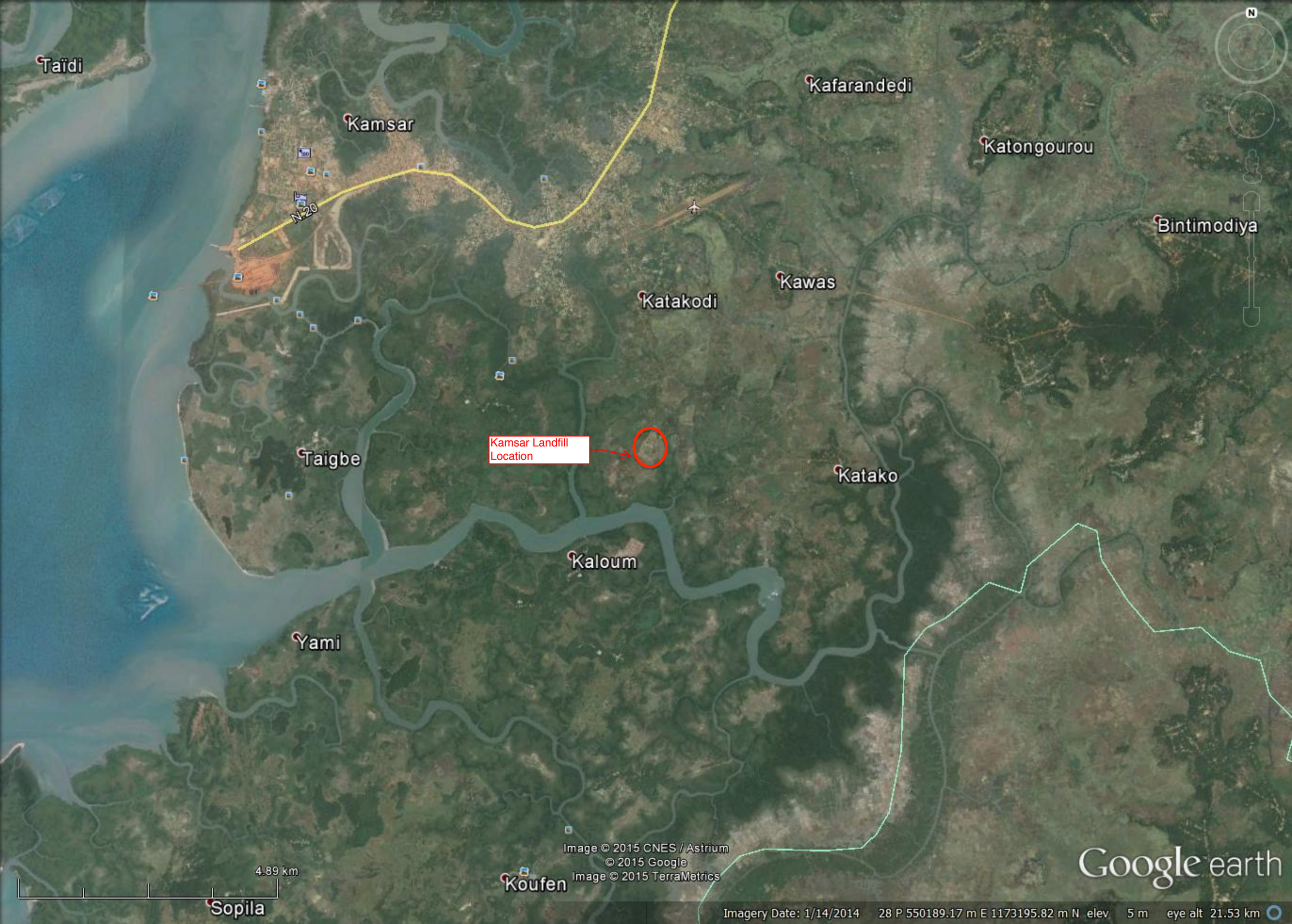
Matrix spikes are conducted a minimum of once during each project run by the laboratory. Field duplicate matrix spikes are normally not prepared. Laboratory duplicates are run in the laboratory on ten percent of the samples subject to testing.

Laboratory analysis results and QA/QC program results are carefully scrutinized on receipt to determine whether the results returned are representative. The laboratory customer services representative is contacted for clarification if any uncertainty associated with the veracity or quality of the results is noted.

SOUTH OF COGON TRIMESTER MINING PLAN FROM 2017 TO 2019




Crusher / Broyeur
Central Shop / Atelier central
CBG Administrative Offices / Bureau administratif de la CBG
WR3
Power Plant / Centrale électrique
Atelier 46
Bauxite Storage Hangar / Hangar d'entreposage de la bauxite
B18
Dryer Stack / Cheminées du sécheur
Bauxite Drop / Chute de bauxite
Bauxite Stock Piles / Piles de bauxite
TA10
WR6
WR2
Tank Farm / Réservoirs
B16
Dryer / Sécheur
Drying Bed / Lit de séchage
WR1
Water Scrubber Pond / Étang d'eau de l'épurateur
0 70 140 m
Scale / Échelle 1 : 7 000
Néné Port / Port Néné
544 000
1 180 000
1 178 000
City North Ditch / Caniveau nord
WR5
Worker's Camp 2 / Camp des travailleurs 2
Kamsar City / Cité de Kamsar
CBG Garage / Garage de la CBG
City Sentry Box / Guérite
Kamsar (Center) / Kamsar (centre)
Kassongeni North / Kassongeni Nord
N.20
GW5
GW4
GW1
GW3
GW2
Kassongeni South / Kassongeni Sud
City South Ditch / Caniveau sud
WR4
Worker's Camp 1 / Camp des travailleurs 1
Wastewater Treatment Facility / Usine de traitement des eaux usées
Arrival Railway / Voie ferrée d'arrivée
SW1
SW4 GAP
Return Railway / Voie ferrée de retour
Dept. 53 - Road Maintenance / Dept. 53 - Entretien des routes
French Berth / Quai Français
SW2 GAP
B2
Train Control Center / Tour de contrôle des trains
Jetty to Ship Loader / Jetée du chargement de bateau
WR7
B18
SW2
WR6
Wall / Mur
WR2
B16
WR1
SW1 GAP
Proposed New Monitoring Well Location
Legend / Légende
Redemption Site / Site de rédemption
Sampling / Échantillonnage
Groundwater / Eau souterraine (GW / B2 / B16 / B18)
Industrial Wastewater Discharge / Eaux usées industrielles (WR)
Surface Water / Eau de surface (SW)


Taïdi
Kamsar
N 20
Kafarandedi
Katongourou
Bintimodiya
Kawas
Katakodi
Kamsar Landfill Location
Taigbe
Katako
Kaloum
Yami
Koufen
Sopila
4.89 km
Image © 2015 CNES / Astrium
© 2015 Google
Image © 2015 TerraMetrics
Google earth
Imagery Date: 1/14/2014 28 P 550189.17 m E 1173195.82 m N elev 5 m eye alt 21.53 km


Proposed Monitoring Well Location
N
Image © 2015 CNES / Astrium
© 2015 Google
252 m
2011
Google earth
Imagery Date: 1/13/2014 28 P 550268.79 m E 1173523.18 m N elev 2 m eye alt 1.17 km

APPENDICES

Appendix 9.5 Water Management Framework

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CBG Water Management Framework

COMPAGNIE DES BAUXITES DE GUINEE

OCTOBER 5, 2015

PROJECT NUMBER: 15OTH076

PREPARED FOR:

Xavier van Lierde, Responsable Approvisionnement – Projet Extension

Compagnie des Bauxites de Guinée

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1 INTRODUCTION

Compagnie des Bauxites de Guinée (CBG) has been operating since 1973. It is proposing to increase its bauxite production at its existing treatment plant and port facilities at Kamsar and mine in Sangarédi in northwest Guinea (the CBG Expansion Project). This document presents the Water Management Framework (WMF). It identifies the key issues relating to water management for the Expansion Project and outlines how CBG will manage its water management risks and comply with IFC's Performance Standards and OPIC's Environmental and Social Policy Statement (OPIC, 2010). The framework will be followed up with a detailed Water Management Plan (WMP) to be released in 2016 following the collection of a year of data from the expanded water sampling and monitoring program started in September to December 2015.

This document has been informed by the data, impacts and mitigation measures identified in the Environmental and Social Impact Assessment (ESIA, 2014), the Supplementary Information Package (SIP, 2015), as well as water related data from CBG and understanding of its current activities. It also builds upon the recommendations of numerous experts and the outcomes of a meeting in Paris in early August between representatives of IFC, OPIC, CBG and other interested parties and their consultants.

The structure of this document includes two main parts. The first part describes:

- The nature of the Expansion Project (Section 2); and
- The existing water system context (Section 3).

The second part deals with impacts to the water system and how to deal with them and includes:

- A statement on CBG's commitment to water protection (Section 4);
- The international and national framework for conserving and protecting water resources (Section 5);
- An assessment of issues related to water protection in the Expansion Project and a strategy for addressing those issues (Section 6);

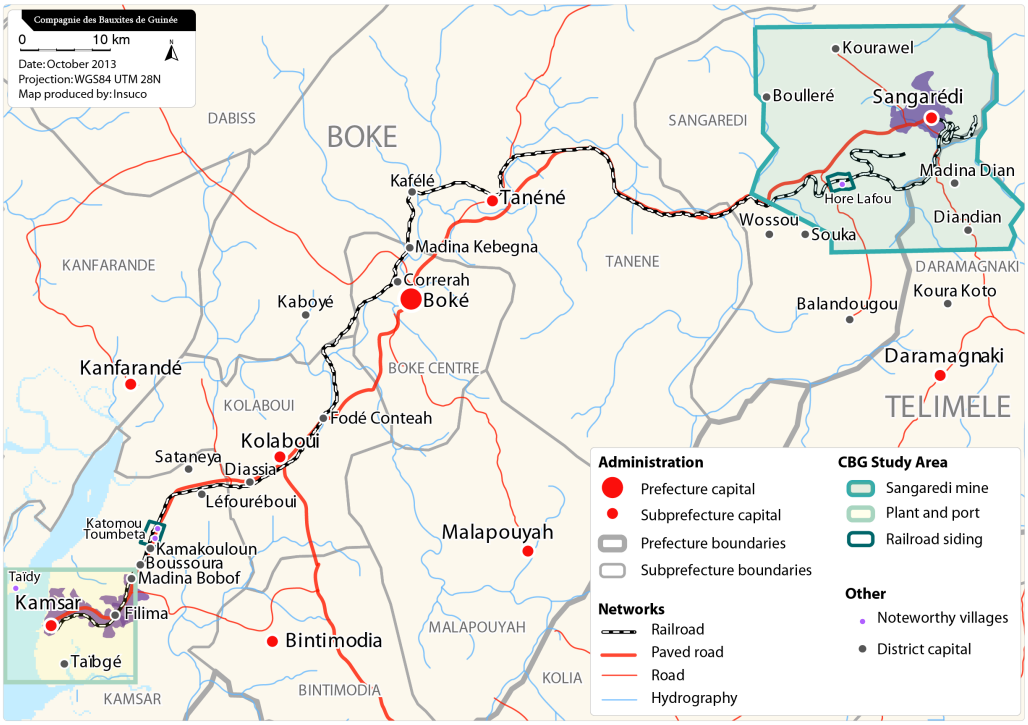
- A discussion of methods of implementing water protection and conservation actions (Section 7);
- A short description of what is to be included in the WMP (Section 8); and
- A short description of the monitoring framework (Section 9).

1.1 Background

Compagnie des Bauxites de Guinée (CBG) is a mining company owned jointly by the Government of Guinea (GoG) and Halco Mining (Alcoa, Rio Tinto Alcan and Dadco). CBG currently mines, transports by railroad, treats and ships about 13.5 million tonnes per annum (MTPA) of bauxite at 3% humidity. The company operates three sites:

- The Sangarédi mining area (plateaus of N'Dangara, Sangarédi, Boundou Wandé, Bidikoum, Parawi and Silidara);
- The railroad network; and
- The treatment plant at Kamsar (including the port).

Map 1 Map of Project area



CBG is considering increasing its bauxite production by 9 MTPA of shipped material to a production capacity of 22.5 (at 3% humidity) by the last trimester of 2017 with another increase of 5 MTPA, to a production capacity of 27.5 MTPA around 2022. An intermediate step is planned at 18.5 MTPA. The CBG Expansion Project (the Project) includes an increase in the rate of bauxite extraction, transport and treatment, and construction and modifications to CBG's infrastructure, equipment and operations.

In 2013, CBG mandated ÉEM to conduct an environmental and social impact assessment (ESIA) of the Expansion Project. This study was conducted according to legal and regulatory requirements at the national level as well as the performance standards of the International Finance Corporation (IFC). The terms of reference were approved by the Guinean Ministère de l'Environnement, des Eaux et Forêts on

November 8, 2013, and the final scoping report was submitted to the Bureau Guinéen d'Études et d'Évaluation Environnementale (BGÉÉE) on December 5, 2013.

The final French version of the ESIA was submitted to CBG on January 10, 2015. The BGÉÉE organized a meeting of interested agencies in Conakry on May 18, 2015 at the conclusion of which it approved the ESIA, subject to clarification on a few points.

1.2 Objectives of the Water Management Framework and Water Management Plan

CBG's approach to water resources is promoting efficient usage, avoiding contamination and ensuring sufficient quality water supply to host communities. As data collection is not yet complete enough to design a comprehensive water management plan, this framework will outline:

- Identification of risks and impacts generally induced to water resources – surface water and groundwater;
- Recognized sound practices to avoid or at least minimize those risks and impacts;
- Commitments to provide specific studies and documents; and
- A proposal for an enhanced monitoring program.

This document is a supplement to the Environmental and Social Impact Assessment and is intended to guide the development of the sections related to water resources of the Environmental and Social Management Plan.

2 PROJECT SCOPE

2.1 Project Area

According to the description of the CBG Expansion Project, its footprint can be divided into three separate zones (Map 1):

- The bauxite mining area around Sangarédi;
- The mouth of Rio Nuñez, an area that encompasses the CBG plant, the mineral loading port and the area used by the ships carrying the ore out to the estuary limit; and
- A corridor along the railroad between Sangarédi and Kamsar, with particular emphasis on two sections where rail sidings are to be built.

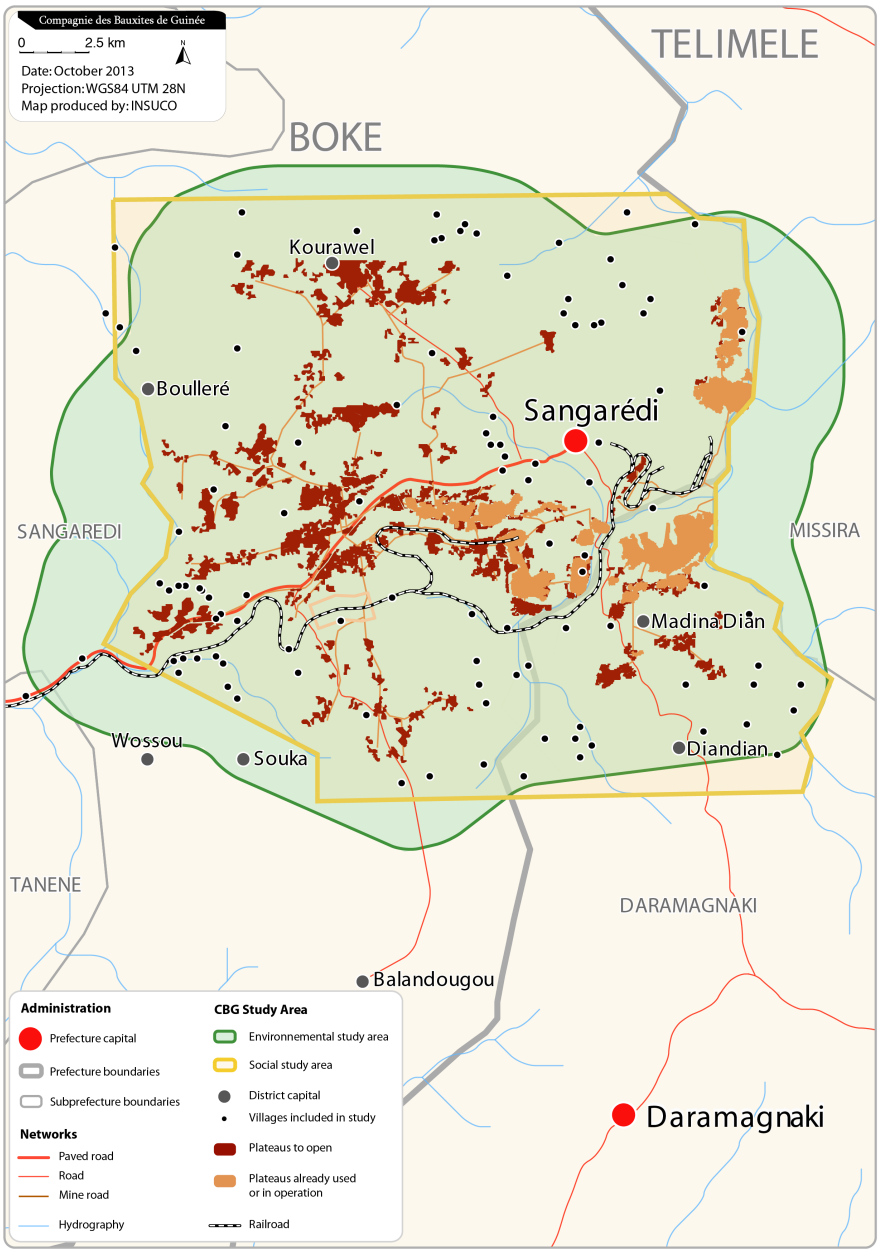
The boundaries of the ESIA Environmental Study Area for the mine (Map 2) correspond to the perimeter of the areas that will be mined, plus an additional 3 km around the perimeter to take into account the effects of mining operations (noise, dust, etc.).

The ESIA Environmental Study Area for plant and port was determined by superimposing two potential impact zones. The first is a 10-km area around the CBG plant and port; this is a conservative buffer for impacts related to air quality and noise. The second is a marine area likely to see impacts from the port facilities and increased marine traffic. This area covers the mouth of Rio Nuñez as well as certain important biological environments nearby.

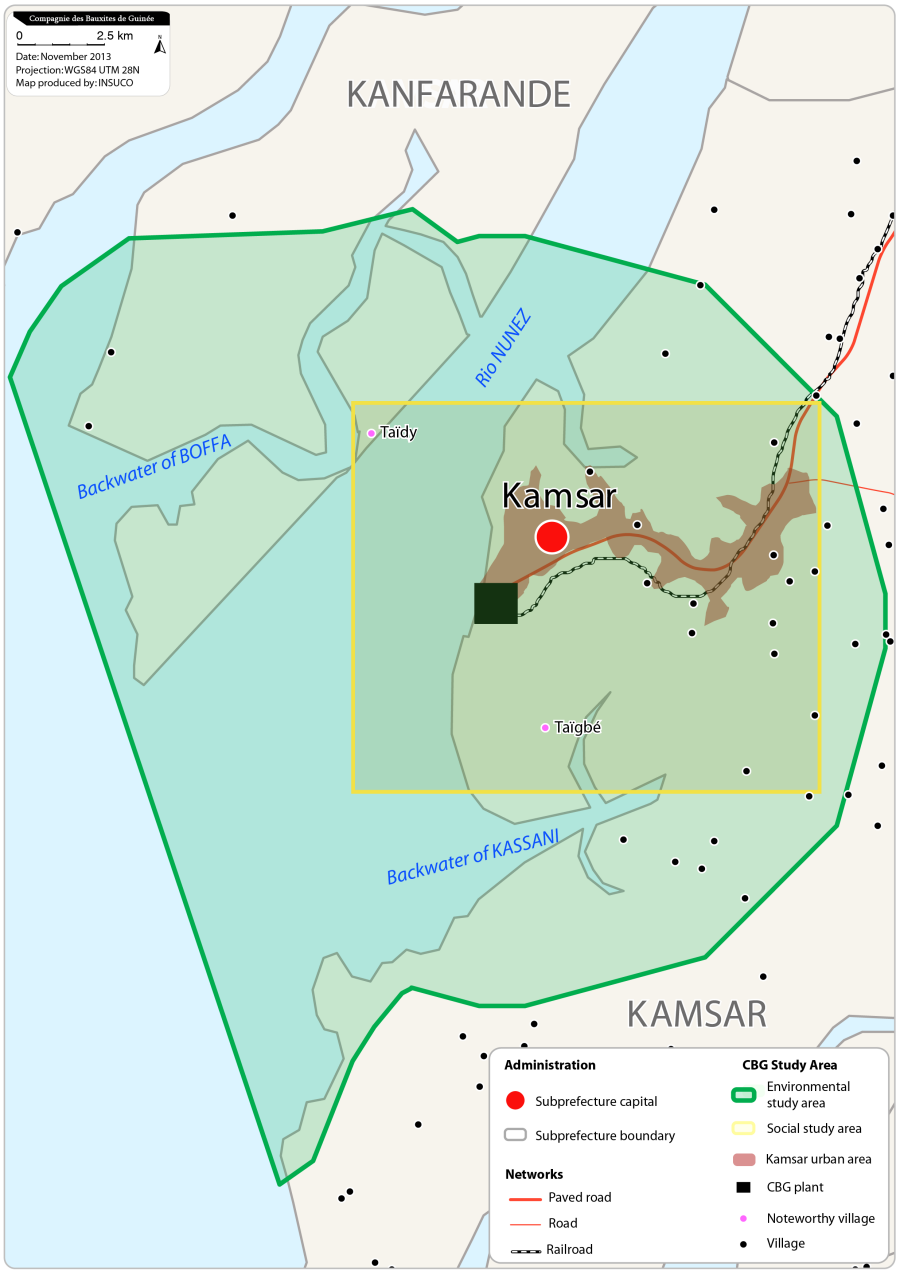
The Study Area for the railroad is a corridor 2 km wide (1 km on either side of the railroad).

The focus in this framework will be on the mining area and second, on the plant/port area. The railroad corridor is not expected to have major impacts on water resources.

Map 2 Sangarédi Study Area



Map 3 Kamsar Study Area



2.2 Project components

The CBG facilities have been in operation for over 40 years. The Expansion Project ESIA looks at the implications of an increase in production rate. Without the Expansion Project the operations would continue as they have, including the gradual mining of all of the new mining areas considered in the ESIA.

At the mine site, the Expansion Project will consist of acquiring equipment (loaders, trucks, bulldozers, water tanks), hiring people to operate it and increasing the rate of extraction from the mines. The use of surface mining equipment will also be studied for ore extraction on some of the plateaus. With the addition of new heavy machinery, the existing shops will no longer be adequate, and new facilities will be built. The footprint of mine trenches for the 2016-2042 period will be about equivalent to the 1973-2015 period.

From the mine, the bauxite is hauled to the Kamsar plant via a railroad line conceded to CBG by the Government of Guinea (ANAÏM).

The plant's modifications are within the perimeter fence of the Kamsar CBG facility and do not directly affect water resources except for the quay. The expansion of ore production will necessitate modifications to the ship-loading quay. Now 275 m long, the quay will be extended by 301 meters so that two Kamsar Max type carriers can be docked at the same time, thereby allowing continuous loading. Lengthening of the quay and expansion of the turning basins will require dredging in the estuary. However, the dredging has been reduced to a minimum. Tidal and processing facility influence on surface waters will have to be monitored as the local landfill influence.

3 WATER MANAGEMENT CONTEXT

3.1 Introduction

There are two distinct environments covered by the Project.

The mine area is a region of plateaus with bauxite deposits cut by a dense network of watercourses and associated valleys. The port and plant at Kamsar are located in a low coastal plain with mangroves and tidal inlets.

3.2 The mining area - Sangaredi

An extensive river network has developed within the mining area. Much of the area drains to the east with rivers such as the Tiapikhouré, Boundou-Wandé, Lafou, and Pora draining eastward to the Cogon River (see Map 1). The Cogon River flows northwest to the border with Guinea-Bissau (379 km) and then southwest until it reaches the Rio Komponi Estuary in the Atlantic Ocean.

The Boundou-Wandé River runs right through the middle of the current footprint of the mine operations, the Tiapikhouré River to the northwest, and the Lafou River parallel to the operations to the south. All three rivers drain eastward into the Pora River, which in turn flows into the Cogon River. Further south, the Sitako River also enters the Cogon River.

A part of the Study Area drains towards the Tinguilinta River watershed finally reaching the ocean by the Rio Nuñez Estuary.

The Cogon River watershed covers a drainage area of 3,350 km^2 and the Tinguilinta River drains an area of 1,891 km^2. The mining area represents approximate 400^2 of headwaters within the Cogon watershed and 150 km^2 of headwaters of the Tinguilinta watershed.

The flow in these rivers varies greatly depending on the season. During the rainy season (July to November) it is expected that the rivers would be at the maximum

flow, while during the dry season some of the small rivers may be dry. The three months of highest rainfall (July, August and September) account for over 60% of the yearly rainfall. The average yearly rainfall at Sangaredi (based on the CBG Sangaredi data for 1972 to 2015) is 2,050 mm, and varies from a low of 1,748 mm (2012) to a high of 2,995 mm (1975). The rainfall data suggest a gradual decrease in annual rainfall over that period.

The permeability (K) of existing soils is not known but soil types such as laterite and bauxite normally have low permeability, so the assumption that most rainwater runs off towards surface water bodies and land depressions is realistic. Percolation rate would be minimal. The precipitation water that drains into mining pits is channelled towards a sedimentation basin from where it percolates slowly to the local aquifer.

Photo 1 Sedimentation basin

CBG has a water treatment plant at Sangarédi to supply the mining operations and part of the town. The pumping station is on the Cogon River dam to ensure supply even during the dry season. There will be an increase in water need during the Extension Project, notably an increase in water required for dust control on roads. For the 27.5 MTPA scenario the predicted increase in water use is 496 m^3 per day. The current amount pumped and treated daily is approximately 4,000 m^3 of which 1,600 m^3 are distributed to the town.

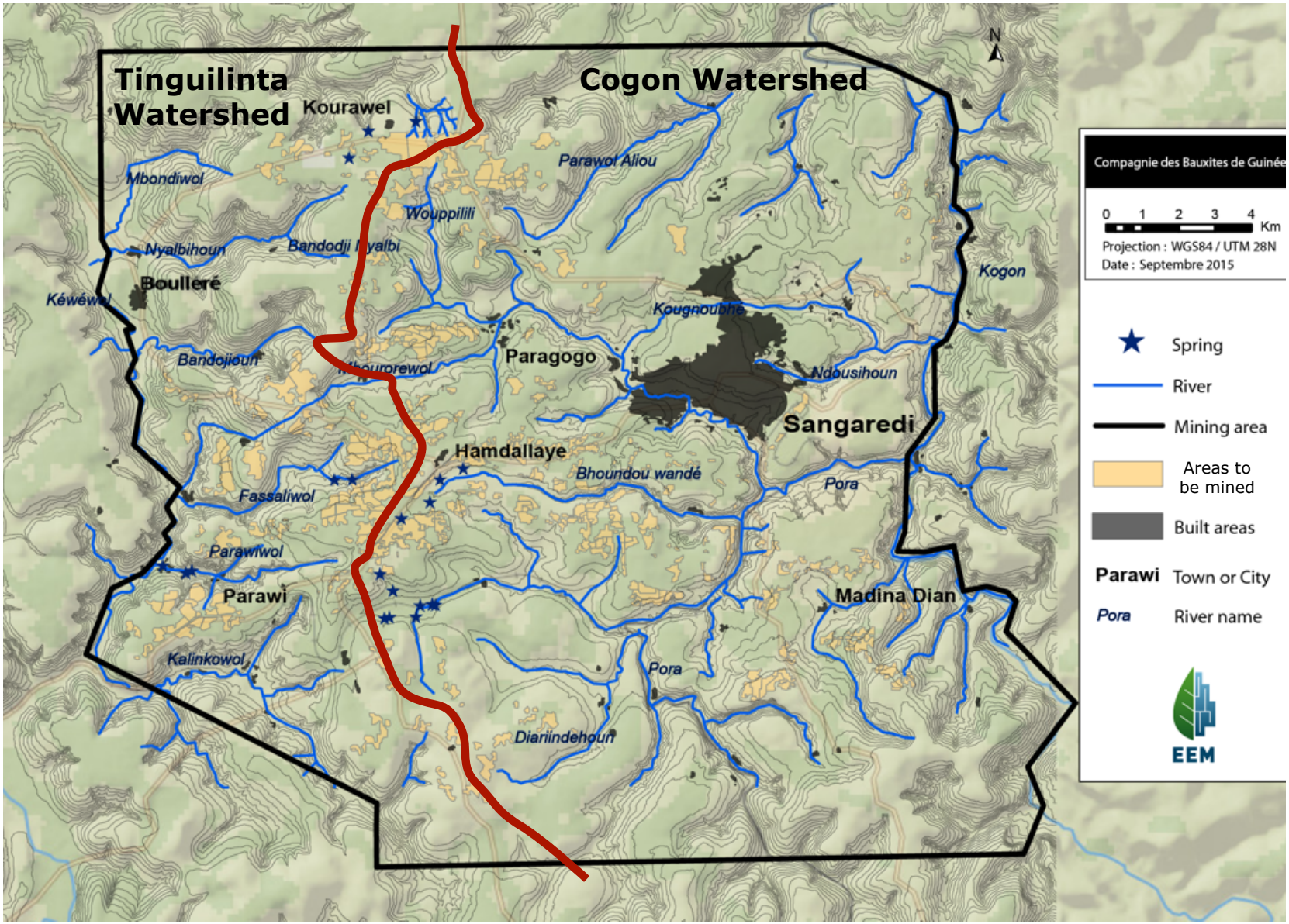
Given the importance of the water volume in the Cogon and the presence of the dam, the impact is considered to be low. The surface of the CBG-Halco concession within the Cogon watershed is approximately 400 km^2. It receives over 2m of rainwater per year, so more than 800 000 000 m^3 of water per year. The additional water needs anticipated by the Expansion Project is of about 500 m^3/d, or 182 500 m^3/y. At first glance, it seems non-significant; even if the evaporation and evapotranspiration would represent 50%, it appears the additional intake would not significantly affect the capacity of the water resources to supply industry and communities.

Springs on the plateau slopes and in the river valleys are of great importance to local villages and to a variety of animals, including chimpanzees. There is a concern that the excavation of pits on the plateaus could affect the springs.

The groundwater system in the Sangaredi area is not well understood and will require data from the proposed monitoring wells to clarify the situation. It is also hoped that data exchanges with the adjacent GAC project might occur and help clarify the situation.

Photo 2 Cogon River at Kogon Lengué

Map 4 Sangarédi watercourses



3.3 The plant and port – Kamsar

The Kamsar study area is located in the Rio Nunez Estuary, at the mouth of the Tinguilinta River where it discharges into the Atlantic Ocean. This is a large coastal river that stretches 160 km across the Boké region and drains an area of 4,858 km². In addition, there are many other rivers in the vicinity of Kamsar, including the Dougoufissa River, which flows in a westerly direction along the southern part of Kamsar and drains into the Rio Nunez estuary in front of the processing facility.

Water for Kamsar currently comes from deep wells at Sogolon (30 km to the northeast of Kamsar) and from the Tinguilinta River via a pumping station near Boké (Batafong). Of the daily received volume of 11,000 m^3, CBG distributes approximately 5,000 m^3 to Kamsar City. For the 27.5 MTPA scenario, an additional consumption of 1,381 m^3 is predicted, to come exclusively from the Batafong pumping station. As the Tinguilinta watershed upstream from Boké is 3,750 km^2, no change of current conditions is anticipated.

The present assumption (ESIA, 2014) for the Kamsar Area is that there are shallow aquifers within the unconsolidated sediments of sands, silts, and clays. These aquifers can discharge large amounts of water into the sea, but there is a seasonal fluctuation during the dry season, where the aquifer is susceptible to periodic saltwater intrusion (and groundwater level lowering) near the coast and along the estuaries.

4 CBG'S COMMITMENTS TO WATER RESOURCES MANAGEMENT

As stated above, CBG is committed to effectively manage water resources during every phase of the project development.

It is understood that this includes meeting Performance Standard 3 of the IFC (PS3), and in particular avoid, minimize, and reduce project-related pollution, ensure sustainable use of resources including energy and water as well as induce no significant impact to users of water resources.

CBG will develop a groundwater model in order to validate the long-term supply of groundwater for environmentally sensitive areas and local communities.

CBG will provide water balances for the Kamsar area and the Sangarédi mining area.

Results from the above will make it possible to identify areas and communities more at risk and ensure more comprehensive monitoring in these areas.

5 FRAMEWORK FOR PROTECTING WATER

The Guinean regulations relating to the protection of water are primarily in the Code de l'environnement (Ordonnance N° 045/PRG/87) of 1987 and the Code de l'eau (Loi n° L/94/ 005/CTRN) of 1994. These texts put into context the protection of water and aquatic resources but do not present specific water quality standards. The Titre 2 of the Code de l'environnement deals with the protection and

enhancement of the receiving environments including soil and subsoil, continental waters and marine waters and their resources.

IFC Performance Standard 3 (Resources Efficiency and Pollution Prevention) (IFC, 2012) deals with specific water issues including water pollution and water consumption:

> The client will avoid the release of pollutants or, when avoidance is not feasible, minimize and/or control the intensity and mass flow of their release. This applies to the release of pollutants to air, water, and land due to routine, non-routine, and accidental circumstances with the potential for local, regional, and transboundary impacts.
>
> …
>
> When the project is a potentially significant consumer of water, in addition to applying the resource efficiency requirements of this Performance Standard, the client shall adopt measures that avoid or reduce water usage so that the project's water consumption does not have significant adverse impacts on others. These measures include, but are not limited to, the use of additional technically feasible water conservation measures within the client's operations, the use of alternative water supplies, water consumption offsets to reduce total demand for water resources to within the available supply, and evaluation of alternative project locations.

The WBG/IFC *EHS Guidelines for Mining* (IFC, 2007) provide industry-specific guidance for mining projects with respect to environmental, occupational health and safety, community health and safety and mine closure and reclamation considerations. The guidelines apply to open-pit, underground, alluvial and solution mining techniques as well as marine dredging for economic recovery (this is not applicable to port operation dredging, which is addressed in the *EHS Guidelines for Port and Harbor Facilities* in Section 2.7.5). They define target performance levels for water use and quality, wastes, hazardous materials, land use and biodiversity, air quality, noise and vibrations, energy use and visual impacts. The guidelines

include performance levels that can generally be achieved in new facilities using reasonable-cost, currently available control technologies. Where the guidelines are applied to existing facilities, it is stated that it may be necessary to establish site-specific targets and an implementation schedule for achieving them.

Recommended practices for water management include:

- Establishing a site-wide water balance with due consideration for mine dewatering;
- Developing a sustainable water management plan;
- Limiting the amount of water used;
- Considering water reuse, recycling and treatment programs where feasible; and
- Consultation with stakeholders (e.g. government, civil society, and potentially affected communities) to understand any conflicting water use demands and the communities' dependency on water resources and/or conservation requirements that may exist in the area.

In addition, CBG has an overall performance and compliance obligation in terms of health, safety and the responsible management of the environment and community relations to ensure that the conditions are met and that employees can work without danger. In the event of an injury or environmental incident, CBG will assume liability.

The following international and national directives guided the approach adopted for managing risks to community health, safety and security:

- IFC Performance Standards;
- IFC EHS Guidelines; and
- Mining Code of Guinea: Chapter VII – de l'environnement et de la santé.

According to IFC Performance Standard 4, the risks and impacts on health and safety to which the affected communities are exposed must be assessed, and prevention and control measures in line with industry good practice must be identified.

The CBG Expansion Project must also comply with Chapter VII of the Mining Code (2011) and with the Code de l'environnement or the applicable international best practices (Article 142). "Appropriate techniques and methods must be used to protect the environment and the safety of the workers and Local Community in accordance with the Environmental Code or international best practices in this area." (Article 142)

6 WATER ASSESSMENT AND STRATEGY

6.1 Main Issues

Some of the main issues to be resolved during the production of the WMP will be:

- Clarification of the depth and areal extent of aquifers present in the Sangarédi area;
- Determination and monitoring of potential impacts from pit excavation on water supply for nearby springs and smaller watercourses;
- Integration of water-related measures in other CBG documents into the WMP to provide a single compendium or signpost of water-related items such as:
    - ✓ Waste Management Plan;
    - ✓ Spill Prevention Control and Countermeasure plan;
    - ✓ Stormwater management; and
    - ✓ Watercourse crossing plans.

6.2 Develop a CBG water management strategy

A CBG Water Management Strategy establishing the company-specific approach to water management, conservation and protection will be produced and presented in the WMP.

6.3 Undertake additional studies and on-going monitoring during the WMP

6.3.1 Field studies and monitoring

An expanded monitoring program for surface and groundwater was described in Appendices 6.2 and 6.4 of the SIP. This program includes:

- An expanded surface water and sediment quality program;
- Determination of surface water discharge at key locations in the Sangarédi area (not recommended for Kamsar because of tidal influences); and
- Determination of groundwater depth and quality using wells at locations in Kamsar, near landfill areas and around mining areas in Sangarédi.

The program is underway with drilling due to start for wells as soon as the conditions become dry enough for access and drilling. The drilling of wells will be done in such as to determine the presence of any aquifers and their depth.

In addition a study of the sediment at the proposed dredging and sediment disposal sites is underway and will help determine if there are any surface water quality concerns.

6.3.2 Water balances

The calculation of an annual water balance is recommended for the Kamsar area and for the mining area. In this latter case, the water balance shall be separated for the Cogon and Tinguilinta watersheds.

Each of the three water balance sheets should include the following annual data or an estimation thereof:

(i) Precipitation
(ii) Surface of watershed
(iii) Proportion of evaporation and evapotranspiration
(iv) Proportion of percolation
(v) Volume pumped from surface for industrial activities
(vi) Volume pumped from surface for communities activities
(vii) Volume pumped from groundwater for industrial activities
(viii) Volume pumped from groundwater for communities activities
(ix) Volume captured in mining trench collection ponds that returned to aquifer
(x) Volume used for dust control
(xi) Volume of industrial effluents (plant effluent and oil/water separators effluent)
(xii) Recharge rate of aquifers

6.3.3 Model of the Sangarédi groundwater and surface system

The WMP will include a model of the Sangarédi groundwater and surface system. The model will be built upon the data gathered during the first year of expanded monitoring and hopefully data exchanges with the adjacent GAC project.

The model will include the main groundwater bodies/aquifers, the locations of springs and surface water bodies (run-off, springs/streams emanating from the plateaux and feeding the valley floor rivers, lakes) and their interaction. The model

will include a map of the distribution of the aquifers, springs and surface waters relative to the proposed areas for mining. The model will help determine the surface water / groundwater interaction and the degree to which the main rivers are groundwater fed.

6.3.4 Identification of sensitive areas

Based on the results of the above plus input from the BAP and the location of springs and communities, the WMP will identify key areas, if any, where there may be changes in water supply that could affect local residents and sensitive species or habitats.

6.4 Revise the impact assessment and mitigation measures

The WMP will include a re-assessment of project impacts on the water system based on the above. The impacts to existing water users (both villagers and important species such as chimpanzees) and to natural habitats will be stressed. Mitigation measures will include storm-water and run-off management, surface water protection and improvements to other related plans (e.g., the Waste Management Plan).

6.5 Improve the monitoring program

Using the additional data from the first year of extended monitoring and the WMP conclusions, the water monitoring programs will be revised to help make sure quantity and quality of water resources will not be significantly affected by the GBC Expansion Project. The WMP will include a gap analysis to identify gaps relative to

the preliminary monitoring network (currently being installed) and the above conceptual model and locations of sensitive / at risk areas and the main flow paths. These gaps, including monitoring at a sufficient frequency and for appropriate parameters, if identified will be closed through changes in the monitoring program.

7 IMPLEMENTATION

7.1 Overview

This section in the WMF remains at a fairly high level. Specifics of implementation will come from more detailed development of the action plan components in the WMP.

7.2 Management System Interfaces

7.2.1 Environmental and Social Impact Assessment (ESIA) and Supplementary Information Package (SIP)

The ESIA is a stand-alone series of documents that reflects information and analysis of environmental and social impacts arising from the CBG Expansion Project as they were understood in December of 2014, as well as commitments to mitigate these

impacts by the CBG. The SIP serves to complement these analyses and commitments with responses to questions and additional information which have arisen since the ESIA's submission to the authorities. Readers must have both the ESIA and the SIP to fully grasp the state of knowledge of the Project's impacts.

The WMP includes and builds upon the measures detailed in the ESIA for reducing impacts to water systems.

7.2.2 Environmental and Social Management Plan (ESMP)

The current CBG ESMP for the Expansion Project is included in the SIP.

The ESMP constitutes the basis for the process of implementing the mitigation measures that were identified in the ESIA throughout the four Project phases: design, construction, operations and closure.

The ESMP is expected to evolve over time and incorporate lessons learned and new data. When the Water Management Plan (WMP) is finished, it will explicitly become part of the evolving ESMP.

7.2.3 Stakeholder Engagement Plan (SEP)

Extensive stakeholder engagement was carried out as part of the ESIA. The present framework takes into account the results of the consultations undertaken under the SEP. Following the production of the WMP, the CBG will consult with stakeholders and explore partnerships. It is only through these partnerships and local involvement that effective protection plans can be implemented.

The SEP developed during the ESIA provides the structure for all interactions among stakeholders regarding the CBG Project, including the consultation process itself.

The final WMP will include a stakeholder engagement program to address water management issues and develop skills in water monitoring amongst the communities.

7.2.4 Resettlement Action Plans (RAPs)

Resettlement action plans are currently underway and will be produced as needed during the life of the Expansion Project. Resettlement of villages can have complex implications for biodiversity (development of a new village site proper, displacement of agricultural activities) and there is a need for ongoing communications and inputs from the WMP and RAPs.

7.2.5 Biodiversity Action Plan (BAP)

A Biodiversity Action Framework (BAF) is included in the SIP and forms the precursor to the BAP, much as this WMF is the precursor to the WMP. The BMP will include analysis of field studies currently underway that will help specify areas of particular concern from a biodiversity perspective. There will have to be ongoing exchanges between the WMP and BAP studies to ensure that relevant aspects are considered in both plans.

7.3 Water system control framework

The water system control framework will work through a series of structures that will include:

- Existing control structures within CBG;
- The ESMP;
- Creation of a water management unit within CBG;
- Plateau management approach;

- Issue-specific management plans (e.g., spring management plan, riparian zone management plan, slope erosion protection plan, water-crossing plan);
- RAPs;
- Stakeholder and partnership roles including establishing a water management working group;
- Compliance audits; and
- A review and improvement procedure.

The water system control framework will be established in the WMP.

7.4 Roles, responsibilities and resources

The WMP will outline specific responsibilities for carrying out and supervising the tasks in the action plans.

One specific role is worth specifying. The management of the various physical monitoring issues in this Project will take considerable skill and expertise. The CBG will therefore name a technician of demonstrated experience and competence on similar jobs to coordinate and oversee the physical monitoring-related tasks.

7.5 Training and competence

The WMP will outline the training and competence requirement of:

- CBG employees in general (orientation sessions regarding water-related matters);
- CBG personnel in a management role;
- CBG personnel responsible for implementing key tasks related to water;
- The physical monitoring specialist; and
- External consultants involved in implementing key tasks related to water.

7.6 Communication

Regular consultation of the public (especially local communities and authorities), and active and continuous public participation, must lead to achievement of the following objectives:

- Provide an opportunity for affected and concerned persons to express their preoccupations and to influence decision making right at the start of the Project;
- Inform and raise awareness in persons or groups affected by the Project or having an interest in it or in its potential impacts;
- Knowledge about the local situation and traditional values;
- Reducing conflict between stakeholders (CBG, civil society, etc.);
- Informed decisions, in particular regarding the most damaging impacts and the mitigation measures;
- Improved transparency and responsibility for CBG; and
- Trust between CBG, government institutions and affected communities.

Regular communication of environmental results and observations is essential. For this reason, an annual report will be produced for CBG management, government authorities and local stakeholders. It will also be sent to lending institutions (such as IFC) and, where applicable, to interested NGOs and other institutions concerned.

The report will contain a copy of all final or annual reports received on the various works under way during the year.

In addition, it will report on incidents such as accidental releases to the water system and will contain summaries of all meetings held with the public or with government bodies on environmental topics.

8 THE WATER MANAGEMENT PLAN

This WMP document will be developed according to the Rio Tinto HSE Standard E101 (Standard E10) and describes the operating philosophy and water management strategy at CBG. Rio Tinto WMP guidelines state the following:

Table 1: Relationship of the Directly Related Standards and Management Documents

Rio Tinto Water Strategy	**Rio Tinto Environment Standard E10 Water Use and Quality Control**
	E10 Water Use and Quality Control Guidelines
Rio Tinto Water Strategy	**RTAW MS CLASSIC Procedures**
CBG Business Plan	4.08 Water Use and Quality Control
Water Management Plan	

Management and Monitoring Programs				
Environmental Water monitoring Program	Stormwater, Erosion and Sediment Control Plan	Hydrogeological Model	Contaminated Site Management Plan	Health & Hygiene Monitoring Program
Water Balance Model	Water Strategy	Artesian Monitoring Program	Hydrogeological Investagtion	

Operational Procedures	
Data, Records and Reports	Procedures, Single Point

8.1 Period of Plan

This plan will be current for four years from January 2016 and will be reviewed annually to ensure continue relevance and adherence. CBG personnel will facilitate the review, utilising the Management of Change system so that relevant changes such as personnel, infrastructure, and procedures will be reflected in this plan.

8.2 Table of Contents of WMP

The WMP is expected to include at least the following topics:

SECTION 1: INTRODUCTION

1.1. Context

1.2. Project description

1.3. Water Management Plan

1.4. Period of Plan

1.5. Regulatory Frame Work

SECTION 2: PARTNERSHIPS AND COLLABORATION

2.1. Social Aspects and Impacts

SECTION 3: RESPONSIBILITY AND ACCOUNTABILITY

3.1. Organisational Chart

3.2. Water Key Site Stakeholders

SECTION 4: CBG WATER STRATEGY

4.1. Background

4.2. Approach

4.2.1. General Principles

4.2.2. Hierarchy

4.2.3. Water Risks

SECTION 5: WATER TARGETS AND EFFICIENCY

5.1. Key Performance Indicators

5.1.1. Sangeredi Key Performance Indicators

5.1.2. Kamsar Kay Performance Indicators

SECTION 6: WATER INFRASTRUCTURE

5.1. Sangaredi Flowsheet

5.2. Kamsar Flowsheet

5.3. Water Storage Dams

5.4. Shallow Aquifer

SECTION 7: WATER CHARACTERISATION

7.1. Surface Water

7.1.1. Climate

7.1.2. Catchment Characteristics

7.1.3. Environmental Values and Water Quality

7.2. Geology and Hydrogeology

7.3. Water Quality

SECTION 8: WATER AND SOLUTE BALANCE

8.1. Introduction

8.2. Water Balance Model

8.2.1. Inputs and Assumptions

8.3. Water Balance

8.3.1. Water Mass Balance

8.3.2. Historical Information

8.3.3. Predicted Water Usage

8.3.4. Predicted Water Usage

SECTION 9: MONITORING AND PERFORMANCE MANAGEMENT

9.1. Environmental Water Monitoring Programs

9.1.1. Operational Monitoring

9.1.2. Health and Hygiene Monitoring

9.1.3. Data Management

9.1.4. Reporting

9.2. Performance and Measurement

SECTION 10: CONTINGENCY PLANNING

SECTION 11: WATER CLOSURE

11.1. Closure Objectives

SECTION 12: REFERENCES

9 MONITORING

Using the additional data from the first year of extended monitoring and the WMP conclusions, the water monitoring programs will be revised to help make sure quantity and quality of water resources will not be significantly affected by the GBC Expansion Project. The WMP will include a gap analysis to identify gaps relative to the preliminary monitoring network (currently being installed) and the above conceptual model and locations of sensitive / at risk areas and the main flow paths. These gaps, including monitoring at a sufficient frequency and for appropriate parameters, if identified will be closed through changes in the monitoring program

Appendix 6.2 of the SIP (surface water and sediment monitoring program) and Appendix 6.4 (well network and monitoring program) will be reviewed and updated specifically to add measurements on quantity of available water. As GBC commits to provide a groundwater model, the groundwater monitoring program will have to be revised according to the model.

Particular care will be devoted to designing a monitoring program for the groundwater at Sangaredi that will focus monitoring activities on the evolving mining operations and adapt that monitoring efforts to the results obtained from the prior monitoring.

The monitoring actions will be detailed in a WMP Register in the full WMP document, a spreadsheet listing all of the actions related to the monitoring, similar to the format used in the ESMP. The costs for the monitoring will likewise be detailed.

The WMP monitoring plans will include:

- A control mechanism and threshold values that launch investigations and/or corrective actions;
- The identification of the responsible person for reviewing monitoring results; and
- A mechanism for updating the monitoring approach based on results.

APPENDICES

Appendix 9.6 Waste management

WASTE MANAGEMENT PROCEDURE

DOCUMENT APPROVAL

POSITION	NAME	SIGNATURE	APPROVAL DATE
Originator	Mohamed Talhaoui		
Manager / Verification	Alpha Tata Baldé		
General Manager	Namory Condé		
Document Owner	Mohamed Talhaoui		

AMENDMENTS

ISSUE	PAGE	DATE	DETAILS OF AMENDMENT	MAJOR / MINOR

TABLE OF CONTENTS

1 PURPOSE 3
2 SCOPE 3
3 DEFINITION 3
4 PROCEDURE 3
4.1 Waste reduction Principle 3
4.2 Waste identification 4
4.3 Collection 4
4.4 Landfill / dumpsites 7
4.5 Waste sorting 13
4.6 Incinerator 18
4.7 Bio-remediation 19
4.8 Competence of service providers 20
4.9 Monitoring of wastes 20
5 RECORDS 21

1 PURPOSE

This procedure is intended to describe wastes management.

2 SCOPE

This procedure applies to all wastes generated during the activities of CBG.

3 DEFINITION

Waste:
Any residue from a process of production, processing or use, any substance, material, product or more generally any object that is discarded or that the holder intends to discard.

NHIW (Non-hazardous industrial waste):
Industrial waste that can be assimilated to household waste.

SIW (Special industrial waste):
Industrial waste containing specific pollutants with such concentrations or characteristics that it cannot be assimilated with household wastes.

IWMS: Industrial Waste Monitoring Slip

4 PROCEDURE

4.1 Waste reduction Principle

- To promote the rule of 3 R: Reduce, Reuse, Recycle
- By avoiding producing wastes
- By reducing losses and dropping of materials
- By storing materials in such a way that they are protected from the weather;
- By privileging healthy materials (best suited to the environment and health)
- By sorting waste upon issuance
- By preventing the evaporation of solvents
- In the case of spills, to dike leak on the floor, to use absorbent kits, to clean up and to manage contaminated materials
- By placing a high emphasis on maintenance and cleaning
- By maintaining all work areas in a clean and orderly condition.
- It is strictly forbidden to throw garbage wherever one wishes.

4.2 Waste identification

Each type of waste produced by CBG will be described in a "waste identification sheet and instructions." This sheet identifies, among other information, the physical characteristics, origin, method of packaging, risks and the method of processing provided of the specific waste.

A register describes, for each type of waste produced by CBG, means and modes of processing in place. This register compiles existing information on:

- Designation
- SIW / NHIW
- CED code
- Identification sheet & instructions
- Authorized service provider for the recovery of waste

The register describes, for each type of waste produced by CBG, means and modes of treatment in place including:

- Collection means
- Actors: Head of Management
- Special precautions
- Initiation of the removal
- Processing mode
- Frequency of removal
- Monitoring registration document

4.3 Collection

CBG has established a number of facilities for waste collection. The main equipment is shown in the following table:

Equipment type		Quantity		Capacity	Waste type
		Kamsar	Sangarédi		
	Compactor dump truck (Rented)	1	1	20 M3	Household wastes

	Dump truck with two movable trays	1	0	20 M3	Various wastes (wood, metal, etc.)
	Tricycle	2	0	4 M3	Household wastes
	FLATBED TRACTOR	2	1	13 M3	Organic wastes
	BACKHOE LOADER	1	1	NA	Household wastes and cleaning of gutters
	BOBCAT	1	0	NA	Household wastes
	Mobile skip bin trucks & 60 skip bins	1 & 80 skip bins	1 & 60 skip bins	5 M3	Various wastes (household, wood, metal, etc.)

	Dump truck	2	1	12 M3	Various wastes (wood, metal, etc.)
	Vacuum for sewer system	1	0	NA	
	Septic pumper truck	1	0	NA	

As part of the optimization of waste collection, CBG has approved the purchase of two new compactor trucks, two skip bin trucks and one vacuum truck. The delivery and commissioning is scheduled for the 1st quarter of 2016. The vacuum truck will be used for emptying septic tanks and to unclog the sewer system in industrial areas and cities.

Photo 1: Model of the ordered compactor truck


Photo 2: Model of the ordered dump truck

Photo 3: Model of the ordered dump truck

4.4 Landfill / dumpsites

- **Dumping ground of Bendougou**

Household wastes from industrial activities of Kamsar and the company town are managed through an engineered landfill in a controlled dump in Bendougou. This dump of 25 hectares is located 13km from the industrial zone in an isolated environment 2.5km from the nearest village. The dump with geo membrane is fenced and under security surveillance. A piezometric drilling was put in place in order to monitor the quality of groundwater.

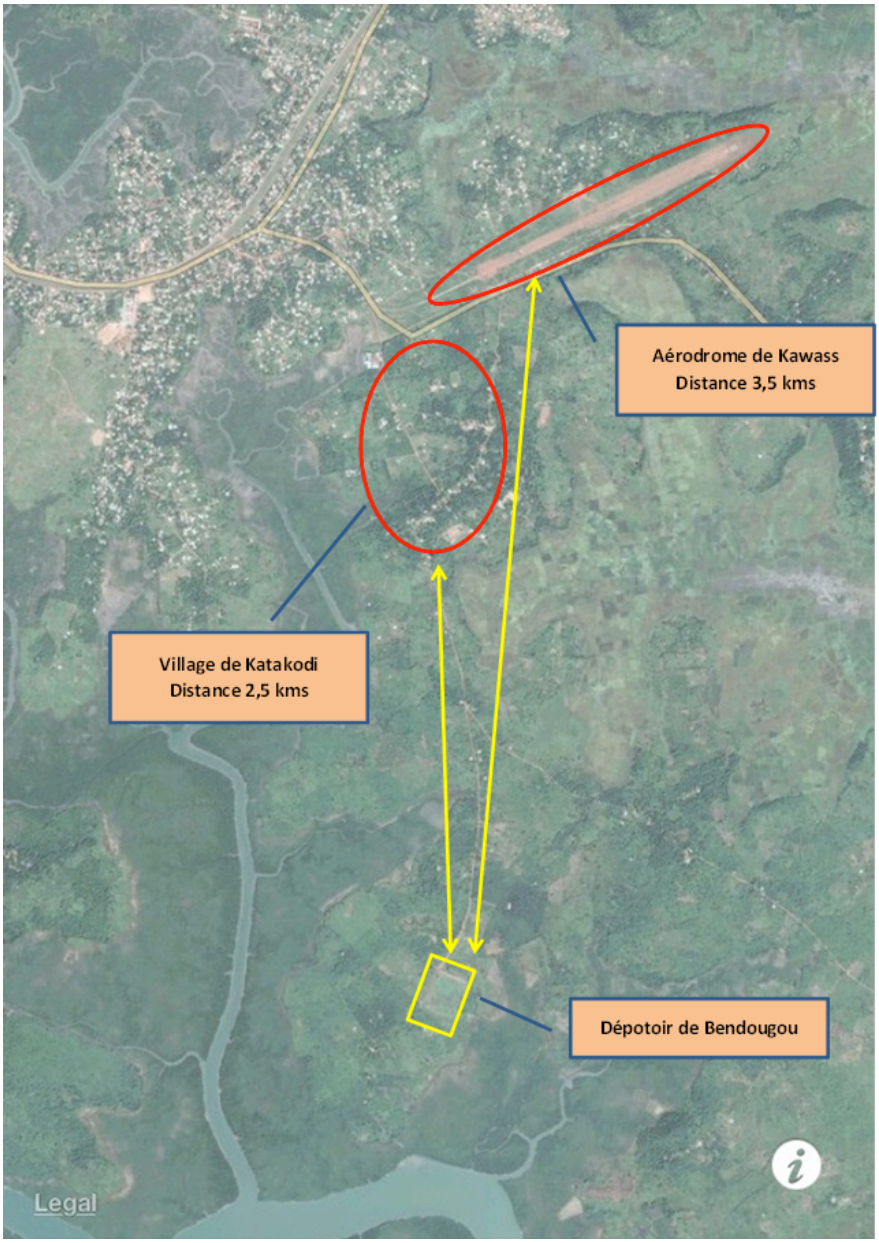


Photo 4: Location of the dump of Bendougou

Photo 5: Overview of the dump of Bendougou

In April 2014, CBG was denied access following multiple claims from communities surrounding the dumping ground for the supply of electricity. After multiple attempts to resolve the issue and in the urgency to manage its daily wastes an alternative was found by establishing a temporary dump in Torabora.

Despite various meetings with communities and the involvement of authorities (Governor, Prefect, Mayor) no solution has yet emerged. However a rapprochement with the management of GAC is in progress:

- To install an incinerator owned by GAC worth $850,000 already delivered on site with an incineration capacity of 1000 kg per hour.
- To give support to resolve the community conflict

Photo 6: The incinerator of GAC currently dismantled on containers

- **Dumping ground of Torabora**

Following litigations created by residents in Bendougou, the use of this site has been suspended. With a vast unused area near the plant and railway, it was decided to use as a dump, the site of Torabora located in the concession of CBG. This site presents the advantages of being close to waste collection sites (fuel economy, greater profitability of collection equipment, reductions in

accident risks for operators and residents, no crossing of the Village and finally safe distance from the first habitations).

The major drawback is the fact that this decision was taken in a hurry; it was not possible to organise an acceptable way, the correct functioning of the dump (no delimited and appropriate dumping and storage zone, no organised sorting, nuisance to communities having to go through waste disposal areas to get to their village, etc.).

Thus, adjustments were made including:

- ✓ Segregation of household wastes and green ones,
- ✓ Spatial delimitation, site reorganisation, securing passage of the communities through the site, without contact with the waste storage areas
- ✓ Securing access to the site, development of the traffic routes of collection vehicles
- ✓ Establishment of a human system of recognition and orientation towards their waste disposal areas and dedicated processing).

The dumping ground of Torabora is an area of storage of household, industrial and green wastes for the exclusive use of CBG. The wastes stored there come exclusively from the industrial complex and the Company town. An authorisation from the environmental authorities has been obtained for the use of the site as a dump.

The dump of Torabora juxtaposes the factory (see Map 1). A Betafence fence has been newly installed in order to secure places, with a security team that monitors and secures the site 24h.

Photo 7: Location of the dump of Torabora

Photo 8: Storage area of the controlled dump of Torabora

A phased development has been set up to ensure the correct disposal of these wastes taking into account landscape integration.

Photo 9: Overview of the dump of Torabora - July 2015

Photo 10: Overview of the dump of Torabora - July 2015

✓ **Dumping ground of Sangarédi**

Household wastes in Sangarédi are conveyed in an area close to the technical area. A management plan is underway to secure the place.

Photo 11: Overview of the dump of Sangarédi

✓ **Management of dumping grounds**

On site there are essentially two separate storage areas:

- Household wastes area
- Vegetable wastes area ("green" wastes)

On site during the unloading of wastes, the dispatcher of the dump carries out the orientation of the equipment undertaking the collection. He/she is the sole authority on site to be able to determine and designate the unloading area of a vehicle according to the nature of its load. The dumpsites are open every working day of the week. Operating hours are from 08:00 to 16:30.

The dispatcher keeps a register in which is mentioned:

- Date and time of arrival of wastes
- Type of equipment
- Driver's name and identification number
- Type of wastes
- Volume of wastes
- Any comments

Outside those hours, the site access shall be prohibited to all equipment; in the case of Torabora, the main portal is closed.

After the gathering, and the distribution of tasks to teams responsible for waste collection (Company town Maintenance Department - Sanitation), the operator of the small backhoe loader, goes to the dump and clean the unloading platform of the storage area of green wastes.

An official from the Company town Maintenance Department - Sanitation liaises with the dispatcher of Torabora, the Safety Security Advisor (Asset Protection) and the HSEC Department.

When necessary, the Company town Maintenance Department requests the support of the fleet division to make available a bulldozer to recover household wastes.

4.5 Waste sorting

CBG is convinced that wastes should be sorted at the place they were produced, during transportation and at the time of disposal. Thus new measures are being taken.

- **CBG Cities perimeter**

Currently 80 skip bins of 5M3 are located throughout the company towns of Kamsar and Sangarédi and industrial areas for the collection of household wastes. Dump trucks are also placed at designated locations to allow the collection of bulky wastes.

Compactor trucks pick up on a daily basis household wastes and green wastes from habitations.

2500 blue bins of 240L were also positioned in front of each house. In addition, CBG has just completed the purchase of 2500 additional green bins. Thus blue bins will only be used for household wastes and green ones for green wastes.

Utility vehicles and trucks made available for the upkeep of the company town are also used for the recovery of bulky wastes.

- **Offices & Industrial perimeter**

Currently 60 skip bins of 5M3 are also placed through the industrial areas for the collection of industrial wastes including wood and metal.

CBG has just acquired specific bins that will be placed at strategic locations to facilitate the sorting of wastes. The sorting of wastes will develop as follows:

- General wastes
- Glass, wood, paper, cardboard and plastics
- Biomedical wastes
- Hydrocarbon contaminated wastes and soils

40 collection points will be set up at the offices for the sorting of waste.

Photo 12: specific bins ordered - August 2015

On industrial zones, CBG has just acquired 80 containers of 1000L of 4 distinct colours to perform the sorting of waste.

All non-hazardous wastes generated from exploration, operation, and construction or from company towns are sent to the controlled landfill of CBG.

Specific wastes:

- **Batteries, ink cartridges, aerosols & neon**

For special wastes of type: battery, ink cartridge, aerosols, neon and for small electrical equipment, CBG recently adopted specific containers for both external and internal spaces. 6 high traffic density collection points have been selected for this purpose.

Photo 13: ordered specific collectors - June 2015

These special wastes are then stored in 20 feet containers pending an appropriate recycling system.

- **Computer and electronic equipment**

Decommissioned computer and electronic equipment are stored in 20-feet containers pending an appropriate recycling system. A strategy of approach is currently being considered to recycle these wastes in a complementary support project especially in the field of education.

- **Used tires**

Used tires are classified as hazardous wastes. Used tires are stored in enclosures with prohibition of entry without permission. They are not in any case burnt or destroyed. One part is reused for marking and delineation of access roads at the mine. They are also used in the arrangement of the intersections of routes or roundabouts. A strategy of approach is currently being considered to recycle used tires for slope stability in erosion control.

- **Used batteries**

Used batteries are classified as hazardous wastes. Maintenance services are in charge of:

- Recovering used batteries of equipment.
- Conveying used batteries in the stores of garages for temporary storage

Used batteries are arranged so as to prevent contamination of soil and subsoil. The storage area of batteries is ventilated, locked with restricted access.

Storekeepers regularly contact the HSEC Department for disposal of used batteries. These batteries are stored in 20-feet containers provided for this purpose.

- **Toxic wastes in dispersed quantities**

CBG has very limited toxic wastes in dispersed quantities mainly generated by its analytical laboratory. Currently these wastes are stored or destroyed by physicochemical processing

including redox, acid-base or simple dilution. These toxic wastes will soon be incinerated in incinerators designed for this purpose.

- **Asbestos**

For asbestos waste disposal, the HSEC management uses a specialised and accredited service provider approved by the National Environment Directorate (NED).

Elimination occurs by burial in a specific area at the mine of Sangarédi approved by the NED. Asbestos wastes are placed in a concrete sarcophagus, which is sealed with geo-membrane. The sarcophagus is covered with laterite. The GPS coordinates of the landfill and the quantity/volume are in a report sent to the NED.

Photo 14: Landfill of asbestos wastes

- **Biomedical wastes**

CBG has a biomedical wastes incinerator for the clinic of Sangarédi. Biomedical wastes from the clinic of the plant are sent to the ANAIM hospital for incineration.

- **Sterile waste**

By the nature of the soil, CBG in its exploitation process of bauxite has only a very limited amount of sterile waste. These sterile wastes essentially consisting of topsoil are reused in the on-going process of rehabilitation.

- **Wastewater**

CBG has two wastewater processing plants in Kamsar and Sangarédi. These stations collect, process wastewater from the company towns of CBG and industrial areas. This processing system

is a type of septic system with intermittent recirculating filter, followed by UV disinfection. No chemicals are used during all processing phases.

In the case of the wastewater processing station of Kamsar, the processed water is reused as industrial water.

Photo 15: Wastewater processing plants in Kamsar and Sangarédi

Part of this industrial water is used to reduce dusts very significantly; indeed the dust emissions attacked with humidity, are collected and deposited as mud in the dust collection lake. The mud thus obtained, is pumped into basins for drying before being reintroduced into the circuit of bauxite.

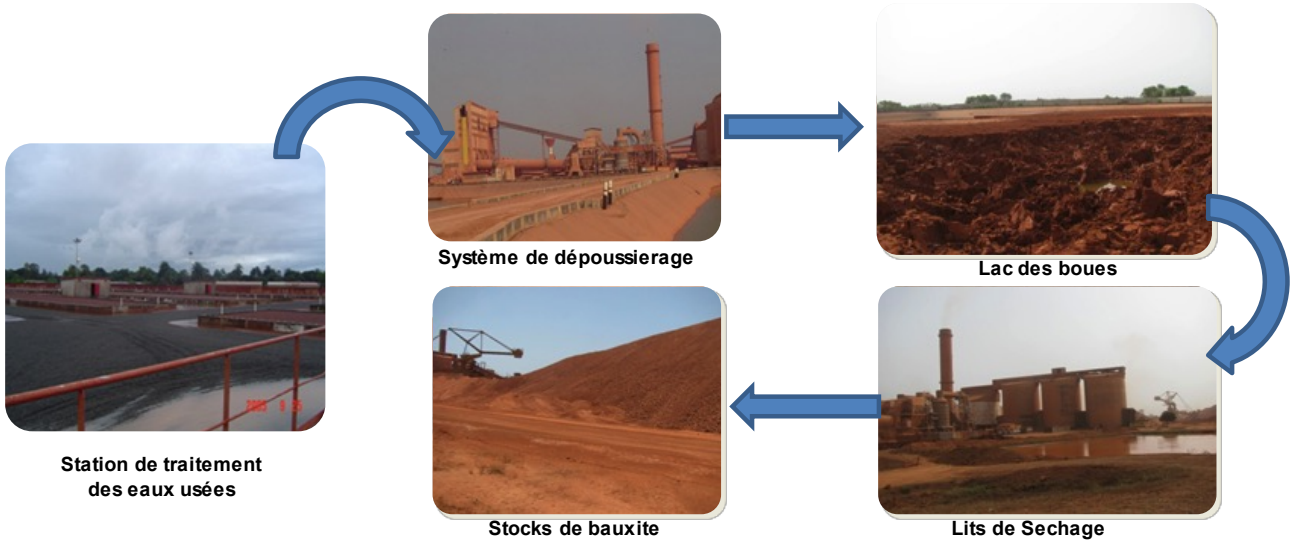


Photo 16: Dust removal process

An operating and maintenance manual describes very precisely the operation of these wastewater-processing plants.

An extension of the sewage system is currently underway.

- **Used oils**

Many double wall tanks of 2M3 and mobile tanks of 5M3 with connectors and pumps are used to store and transport used oils from industrial facilities in Kamsar and in Sangarédi. These used oils are also collected, stored for combustion in the drying ovens for bauxite.

A new modern effluent processing station has just been commissioned. All effluents are collected from the gutters, and oils recovered by the separator are stored in tanks to be burned in the drying ovens for bauxite.



Photo 17: Effluents processing plant

4.6 Incinerator

CBG will acquire two containerised incinerators with a destructive capacity of 100 to 120 kg per hour and a combustion furnace with a volume of 2m3. These two incinerators will be placed at the dump of CBG in Kamsar near the unloading platform of the compactor trucks. Sorting will be conducted to differentiate wastes. Reusable wastes (wood, plastic bottle, glass, aluminium, etc., or those to be recycled will be placed in 20-feet containers with an in-bulk conditioning method, in drums, in tanks or palletised.

Photo 18: Incinerators ordered - July 2015

4.7 Bio-remediation

CBG has implemented a bio-remediation process for the degradation of oil from contaminated soils. Thus a site has been selected for this purpose. Clay was used for waterproofing. An existing procedure describes in detail the operation process of bio-remediation. In the context of continuous improvement, a working group has been set up to review the operation put in place and corrective measures will be implemented.

Photo 19: Bio-remediation site

Oil Spill Landfarming

Soil contaminated area design

4.8 Competence of service providers

It is forbidden to use an unauthorised company for the removal or processing of waste. CBG ensures compliance of waste disposal and processing service providers with Classified Installations for Environmental Protection and the transportation of wastes.

The Environmental manager will hold the list of suppliers and documents proving their competence in waste disposal and processing. He/she will transmit this list to the purchasing department after each update.

In the case of a new service provider for the collection or processing of waste, the department informs the Environmental manager prior to the intervention to check their authorisation.

4.9 Monitoring of wastes

The register will be set up to monitor types of wastes recorded, the removal procedure and the processing on the sites. The Environmental Manager will update the table monthly in order to know the amount of waste produced, valued and evacuated.

The weighing of wastes will be done once before the delivery and incineration of wastes at the location indicated. An industrial waste monitoring slip will track the waste to its final destination to ensure compliance and adequacy of its processing.

A piezometer exists at the dump of Bendougou. A program is underway to identify and add piezometric points for:

- The dump of Sangarédi
- The dump of Torabora and Kamsar
- The bio-remediation site

These piezometers will monitor the quality of groundwater and identify possible pollutions. Water tests will be carried out regularly throughout the monitoring program under development.

5 RECORDS

Document Number	Description	Archive Period
CBG_HSEC_ENR_4011	Waste identification form & instructions to follow	
CBG_HSEC_ENR_4012	Type and management of waste, recycling and Monitoring channels.	
CBG_HSEC_ENR_4013	BSDI	